MECHANICAL THERAPEUTICS.

A

PRACTICAL TREATISE

ON

SURGICAL APPARATUS, APPLIANCES,

AND

ELEMENTARY OPERATIONS;

EMBRACING

BANDAGING, MINOR SURGERY, ORTHOPRAXY, AND THE TREATMENT OF FRACTURES AND DISLOCATIONS.

BY

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WITH SIX HUNDRED AND FORTY-TWO ILLUSTRATIONS.

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PREFACE.

In offering to the profession the present volume on mechanical therapeutics, the author would state that his design is to place in the hands of students and practitioners of medicine a systematized and condensed description of surgical dressings, apparatus, and elementary operations, drawn from the writings and teaching of the ablest surgeons in America and Europe. In its preparation care has been taken to adapt it also to the necessities of those wishing to enter the public service, inasmuch as the rigid and thorough examinations of our Military and Naval Medical Boards require more minute and extended information upon these subjects than can be obtained from the ordinary text-books.

The author has availed himself of the advantages offered him in hospital and private practice, and has submitted to actual trial most of the plans of treatment described in the work, noting at the time their advantages and disadvantages in the cases in which they have been recommended by their authors. All embarrassing generalities have been avoided as far as possible in the descriptions, each step in the preparation and application of apparatus being minutely detailed.

In a work of this nature it was indispensable for the easy understanding of the subjects treated that it should be fully illustrated. Many engravings introduced throughout the volume have been drawn from the well-known works of Velpeau, Gross, Miller, Erichsen, Fergusson, Druitt, Skey, Pirrie, and Sargent; while the author would also acknowledge special indebtedness to the elaborate treatises of Hamilton, Malgaigne, and E. R. Smith, on fractures and dislocations;

to Goffres' "Prècis des Bandages, Pansements et Appareils," Jamain's "Manuel de Petite Chirurgie," and to Bigg's Orthopraxy.

The skilful surgical mechanicians, Mr. Kolbe and Mr. Gemrig, of Philadelphia, have been courteous enough to place at his disposal models and drawings of the latest surgical apparatus and appliances.

PHILADELPHIA, Nov. 1867.

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IN

SURGERY.

PART I.

OF THE "APPARATUS OF DRESSING."

By the term "Apparatus of Dressing," or, more simply, Apparatus, are meant, technically, all the portions or pieces of a surgical dressing, with the instruments used in their application. For convenience of description we shall divide the apparatus into four parts:—

1st. The instruments of dressing.

2d. The first pieces of dressing, or those applications which are placed in direct contact with the skin, as lint and adhesive plaster.

3d. The second pieces of dressing, or bandages properly so called, as the roller and its modifications, and intended to be placed over the first pieces to retain them in the situation they are designed to occupy.

4th. Those mechanical contrivances variously called apparatus, mechanisms, or machines employed in the treatment of deformities, fractures, and dislocations.

Surgical dressings may be defined to be the proper and regular application of mechanical means, or topical remedies, to parts diseased or injured, from internal or external causes, with a view of restoring them to health.

It requires on the part of the surgeon ingenuity and dexterity only to be acquired by long practice to obtain all the advantages procurable from the proper and methodical application of surgical dressings, bandages, and apparatus.

CHAPTER I.

OF THE INSTRUMENTS OF DRESSING.

In the daily routine of duty, in dressing and performing elementary operations, experience has taught us the utility of certain instruments which, for convenience, security, and portability, are usually arranged upon an oblong piece of leather under little loops, and, folding up in a compact form or packet, is called the *pocket-case.*

A considerable amount of taste and judgment as to the number and kind of instruments, with which he fills his case, may be displayed by the surgeon, but we intend to limit our descriptions to those only which are of real practical use.

There are two kinds of knives, *scalpels* and *bistouries*, differing from each other simply in the width of the blade, the former being more or less broad, and the latter narrow.

SCALPELS vary among themselves, not only as regards the size of the blade, but also in the degree of convexity of its cutting edge, according to the individual views, convenience, or taste of the operators. The blades are articulated with handles of horn, ivory, or tortoise shell, either fixedly, as in the ordinary operating scalpel, or movably. In the latter case, the handle consists of two lateral pieces riveted at one end with the heel of the blade, and at the other with a small intervening fragment of ivory to separate them at a convenient distance for the reception of the blade. By this arrangement the cutting edge (Fig. 1) is protected, and the lateral pieces being open

Fig. 1.

Single-bladed scalpel.

upon both sides, front and back, the instrument may be thoroughly cleansed from blood or moisture which, if permitted to remain, would rust the blade and render it unfit for use. Upon the handle, near the rivet, there is an oblong slit with a little pin playing in it, to slide behind the apex of the heel to maintain the blade open when the knife is in use, so as not to risk injuring the operator's hand, or the patient, by any sudden and unexpected closure, or to permit the blade opening when it has been shut and the instrument placed in the case. It is the custom now, in order to diminish the number of instruments in the *pocket-case*, to rivet two blades, instead of one, to the handle, as seen in Fig. 2.

Fig. 2.

Double-bladed scalpel.

For the purpose of operating, those scalpels are the best with the blade and handle immovably articulated and the lateral surfaces of the latter somewhat roughened, which enables the surgeon to seize

them firmly, so that they are not apt to slip from his hand when covered with blood. The common forms of scalpels now in use are seen in the annexed sketch. Fig. 6 shows one with a moderately convex edge, the point at the summit of its axis, and the back slightly

Fig. 3. Fig. 4. Fig. 5. Fig. 6. Fig. 7.

Different forms of the scalpel.

convex at the anterior part of the blade, with two narrow lateral facets joining behind and forming a cutting edge, which will be found, generally, the most convenient and useful in making incisions and dissections.

The pocket-case is occasionally furnished with three or four blades of different sizes fitted to one handle, in such a manner that they may be articulated or disarticulated at pleasure, and when not in use they are secured, under loops, to a small piece of leather folding upon itself, and kept in one of the compartments of the case.

Bistouries.—There are four forms of the bistoury in constant use, in the daily routine of practice: 1st. A straight (Fig. 8) and sharp-

Fig. 8.

Straight bistoury.

pointed instrument which is exceedingly light, and well adapted for making neat incisions, and is preferred by French surgeons for operating. 2d. The straight and blunt-pointed bistoury is employed sometimes, in the neighborhood of important arteries, nerves, and other organs, to avoid puncturing them when the incisions are carried to a considerable depth, and where, perhaps, the point of the finger alone guides the knife. 3d. The curved sharp-pointed bistoury (Fig. 9) is in more continual demand by the surgeon for incising and punc-

turing than any of the varieties of this instrument. It is made to act in most cases from within outwards, as in opening abscesses or other

Fig. 9.

Curved sharp-pointed bistoury.

morbid fluid collections, slitting up sinuses and fistulas, and in incising the tissues upon a director. 4th. The last form of the bistoury (Fig. 10) is curved and blunt-pointed. Its utility is restricted to a

Fig. 10.

Curved blunt-pointed bistoury.

small number of cases, such as relieving deep-seated strictures in strangulated hernia, incising subcutaneous bridles, dividing tendons, and laying open the skin upon the grooved director.

Scissors.—Although not absolutely necessary, three pairs of scissors of different forms will render the pocket-case more complete and convenient; they are the straight (Fig. 11), the angular (Fig. 12), and those curved upon the flat (Fig. 13).

These instruments should be sharp, and their blades so riveted together as to enable the operator to bring their edges in contact perpendicularly that they may not catch, nor yet separate so far as to allow the tissues or linen to slip between them, and be crushed, instead

Fig. 11.

Straight scissors.

of being neatly divided. The rings should be out of the axis of the stems and permit these to lie in close contact.

Charrière, of Paris, has modified the manner of articulating the blades in the following manner: one of them is provided with a tenon upon its inner side, and the other with an elliptical slit, or perforation, which receives the tenon in such a way as to preclude the possibility of their separation, however wide they may be opened. The advantage claimed for this plan is that the blades can be disarticulated at will and thoroughly cleansed; the old arrangement not permitting this, the blood or fluid of any kind with which the scissors may have been brought in contact collects about the rivet and rusts it, and thus

prevents their free play; or, worse yet, loosens the blades to such an extent that their edges bruise the objects brought between them. Nevertheless, the tenon wears by constant use and permits the blades

Fig. 12.

Scissors curved on their edge.

to separate, so that the last objection holds also against the new arrangement.

The straight scissors are generally used for cutting dressings and bandages; those curved on the flat for removing any excrescences, as warts, &c., and for operating in cavities where straight blades could not act to advantage, if at all. The angular scissors, or those curved upon the edge, will be found convenient in dividing the tissues raised

Fig. 13.

Scissors curved on the flat.

upon a director; laying open fistulous canals—the angularity permitting one of their blades to be slid under the skin in a parallel direction. It is the proper instrument to use, also, when a roller bandage is to be removed.

In using the scissors they are, commonly, held by the thumb and the middle or third finger being placed in their rings, while the index finger is extended along the side for the purpose of steadying them; however, convenience and habit are the best guides in this matter.

Razor.—It is always desirable to have a razor in the pocket-case, to remove the hair from those parts upon which dressings are to be applied or an operation performed; it is an inelegant habit to use the

Fig. 14.

Razor for the pocket-case.

operating scalpels and bistouries for this purpose, to say nothing of the damage it does their edges. Fatty substances applied to hairy

surfaces glue the hairs together in hard and irritating knots, or cause them to adhere to the dressings, rendering their removal difficult and painful.

In manipulating with the razor apply its blade nearly flat to the part, and then by a quick sawing motion cut the hair from above downwards.

FORCEPS.—There are two pairs of forceps in the pocket-case: the dressing or ring forceps and the artery forceps.

The dressing-forceps are commonly constructed like the scissors, except that their anterior branches are made in the form of stems which are broad at their extremities and grooved transversely in five

Fig. 15.

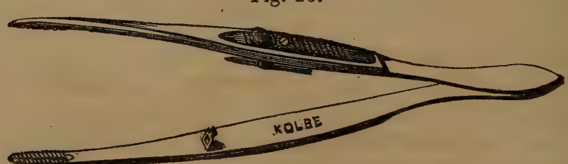
Dressing-forceps.

or six little eminences upon their inner surface, forming jaws which, when closed, interlock, so that a firm hold may be had upon anything seized by them.

A still better form of this instrument (Fig. 15) is that modelled after the French polypus forceps, the branches of which cross each other in such a manner that the stems occupy less room, opened, than when they are closed. When the dressing-forceps are employed they may be held in the same way as the scissors.

The artery forceps (Fig. 16) resemble those used in dissection, in having their blades solidly riveted to a small piece of intervening steel at one end, and separating at the other by their own spring. They are held between the thumb and the index and middle fingers; and should be so constructed as to be easily closed by gentle pressure, for any unusual stiffness of the spring tires the fingers. The outer

Fig. 16.

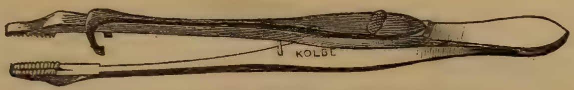


Artery forceps, with slide.

surfaces of the middle sections of the blades are file-cut, to prevent the instrument slipping from the fingers when bloody. The inner borders of their points are grooved transversely to enable them to retain any object seized; and crossing these perpendicularly is another groove terminating above in a little round pit, to receive a pin or a needle. To secure the blades fixedly upon the object between their jaws, a catch-slide or spring is fitted to them.

For holding pins or needles in making the twisted suture the forceps seen in Fig. 17 are better adapted than the preceding; the slide

Fig. 17.



Forceps for holding pins in making twisted suture.

presses directly upon the points of the instrument, and must, therefore, necessarily cause these to grasp the pin more firmly.

Forceps are designed to replace the fingers in situations where these could not be used to advantage, or where the objects are too small to be grasped by them. The ring forceps are used to remove soiled dressings from wounds, and loose fragments of bone or other foreign bodies from the tissues.

The artery forceps have finer points, and are suitable for seizing small objects, such as pins, threads, &c., and the mouths of bleeding vessels for ligation and torsion, though in the latter case the points of the instrument are liable to be caught in the loop of the thread when the knot is being tied upon the artery; to obviate this annoyance the forceps seen in Fig. 18 are used. They have broad and arched jaws,

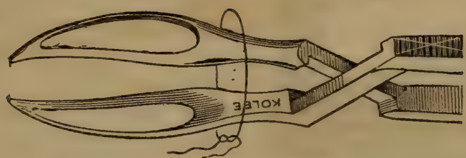
Fig. 18.

Artery forceps with arched points.

which throw the loop from their sloping sides upon the artery when the knot is drawn tight. To confer additional lightness, the points of the forceps are also fenestrated.

Another form of artery forceps is seen in Fig. 19; they are of the

Fig. 19.



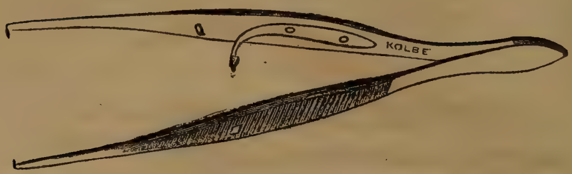
Artery forceps closing by their own spring.

same shape as the former, but their blades cross each other in such a manner as to close by their own spring.

Liston's bull-dog forceps have their points armed with little teeth, and the blades are held together by a spring, as seen in Fig. 20.

Velpeau (*Operative Surgery*, vol. i. p. 92) advises the addition to the pocket-case of a pair of forceps armed at their extremities with three

Fig. 20.



Liston's forceps.

Fig. 21.

Tooth-pointed forceps.

small mouse-like teeth, two upon one side and one upon the other, which can in some cases be used with extreme advantage (Fig. 21).

TENACULUM.—The tenaculum is a delicate sharp-pointed hook with its heel fixed in a handle like a bistoury. It is used to draw out the

Fig. 22.

Tenaculum.

mouths of bleeding vessels to be ligated, and sometimes for the torsion of small arteries.

LANCETS.—The thumb-lancet (Fig. 23) is a short-pointed blade with a cutting edge upon both sides, for a third of its length. Its heel is articulated with a handle, the lateral halves of which, being free at their remote ends, are movable upon each other, permitting the instrument to be easily cleansed. The cutting-point varies in length; and, from its shape, is sometimes called the oat-eared, the barley-eared, and the serpent-tongued lancet. Either of these is used according to the greater or less depth at which the vein, or collection of matter can be reached.

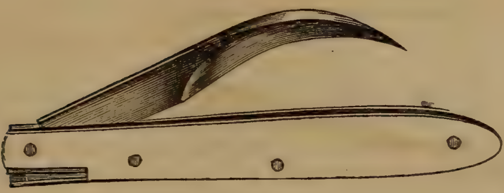
Fig. 23.

Thumb-lancet.

Some persons have deemed a special instrument necessary for opening abscesses; it is constructed like the ordinary thumb-lancet, but with a broader and longer blade, and an elongated and slightly curved point (Fig. 24).

Special vaccinating lancets are sometimes employed; they have blades quite narrow, and a groove a quarter of an inch long in their

Fig. 24.



Syme's abscess lancet.

axis, and terminating at the point to permit the ready flow of the vaccine matter beneath the epidermis.

The *gum-lancet* consists of a narrow stem with a curved cutting

Fig. 25.

Gum-lancet.

point, and its heel riveted to a handle in the manner of the tenaculum. Its name sufficiently indicates its use.

PROBES.—Probes are delicate metallic stems for exploration, and should be made of silver, in order to be sufficiently tough and flexible to assume any shape required by the devious courses of wounds and fistulas. They are of three kinds—the *simple*, the *eyed*, and the *grooved* probe; all of them have at one end a little globular enlargement. The simple probe has the other end terminating in a sharp point of a prismatic shape; the second (Fig. 26) has an eye, which

Fig. 26.

Simple probe.

serves the purpose of inserting a seton, or passing a ligature; and the grooved probe, as its name indicates, has a narrow canal coursing half its length, and is employed to direct the point of a knife in laying open very contracted sinuses.

The military surgeon sometimes avails himself of a cylindrical metallic stem, usually in two or three sections, and called the *gunshot*

Fig. 27.

Gunshot probe.

probe (Fig. 27), for exploring at greater depths than any ordinary probe would permit him to go.

THE PORTE-MECHE (Fig. 28).—One may often conveniently avail himself of the assistance of a little instrument called the porte-meche for inserting threads or tents into narrow wounds, fistulas, or other cavities. It is simply a stem of silver, with one of its extremities notched or forked to hold the threads, and the other terminating in a

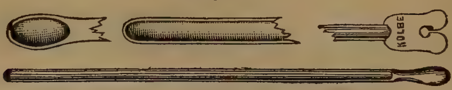
Fig. 28.

Porte-meche.

little button. To use it, place the central part of the meche upon the fork, and draw its ends along the sides of the stem towards the button, which rests against the palm of the hand, while the thumb, index and middle fingers support the stem and the meche at the same instant.

The Director.—This is a grooved steel stem four or five inches long, terminating at one end in a cul-de-sac, and at the other in a broad plate fissured at its centre, and by which it is supported with the thumb and index-finger. The split plate may be employed in steadying contracted bridles while they are being divided, as the

Fig. 29.

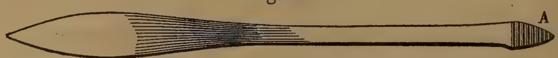


Directors.

frænum of the tongue. The groove in the stem acts the part of a conductor for the point of a knife or scissors in slitting up sinuses. The point of the director is an excellent means for dividing or tearing through the cellular tissue over an artery, for the purpose of ligating it.

The Spatula.—The common spatula is a narrow, thin steel plate, four or five inches long, used for spreading plasters and cloths with cerate, and for scraping fatty or other offending matter from the skin. The French spatula (Fig. 30) is a much more useful instrument, and,

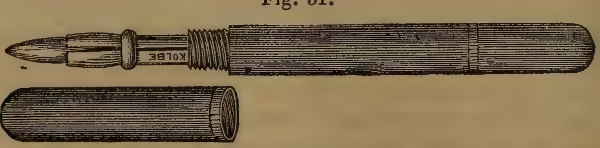
Fig. 30.



Spatula.

like the preceding, is made of steel; one-half of its length is expanded into an elliptical plate, convex on one side, and with a crest running along the middle of the other, bounded laterally by two concave surfaces; the other end forms a stem with a transversely grooved point, and makes a good elevator; the broad portion answers the same purposes as the former spatula.

Fig. 31.



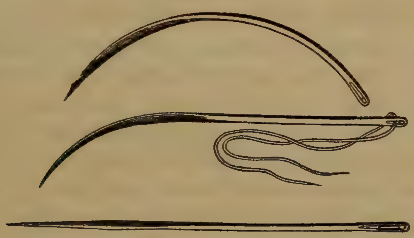
Porte-caustic.

The Porte-caustic (Fig. 31) is a simple hollow cylinder or tube of silver, vulcanized India-rubber, or ebony, to receive a stick of nitrate of silver, which serves a great variety of surgical purposes, as the curing of chronic inflammations, repressing exuberant granulations,

and stimulating indolent ulcers. The porte-caustic, as it is usually furnished by the manufacturer, is in three parts, fitting together; one end of the middle section supports a cleft tube of platinum, with a ring sliding upon it to hold the caustic, while the other contains a reserve supply of this article, preserved from the air by the cap or third section shutting it up in the tube. The caustic pencil should be carefully cleansed of all moisture before inclosing it in the case. Besides the nitrate of silver, it will be found advantageous to have a crystal of the sulphate of copper, trimmed to a blunt point, in one of the compartments of the pocket-case. It is used in similar cases as the lunar caustic.

Needles (Fig. 32).—There should always be an ample supply of surgical needles, both straight and curved, in the pocket-case; also a number of common sewing-needles, and

Fig. 32.

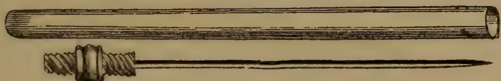


Surgical needles.

such pins as are used by the entomologist, for the twisted suture. The needles ought to be kept bright and clean by smearing them with a little mercurial ointment before being put away.

The exploring needle (Fig. 33) is of large size and grooved, mounted upon a handle which at the same time

Fig. 33.



Exploring needle.

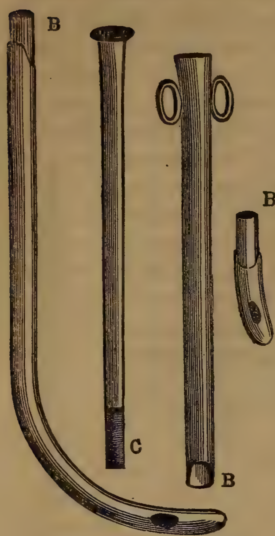
forms a sheath for it when not in use. The exploring trocar (Fig. 34) is simply a long needle furnished with a tube like the ordinary trocar. These instruments enable the surgeon to explore the nature of tumors, and to remove a specimen from their interior. The greatest discrimination should be exercised in employing them, as great injury may be done the patient by the injudicious puncturing of certain morbid growths.

The Artery Needle is a curved metallic stem, with a broad-eyed point, mounted upon a handle, in the manner

Fig. 34.

Exploring trocar.

Fig. 35.



Catheters.

of a tenaculum. It serves the purpose of passing a ligature around an artery.

Catheters (Fig. 35).—There should be at least two male and a female catheter in the pocket-case. For portability, they are made in short sections fitting to each other. The tubes are of silver, and consist of a main stem or body four or five inches long, the free end of which has two little rings soldered to its sides, for the attachment of a retentive bandage; the other end is bevelled to receive three different shaped beaks: the first is short and slightly curved, and converts the tube into a female catheter; the other two are long and very much curved, and, being of different sizes, supply the surgeon respectively with a No. 7 and a No. 3 male catheter. The bevel upon the distal end of the main stem prevents the beaks rotating, while they are kept from slipping off the body by means of a male screw cut upon the extremity of a second tube, C, running through the body, and working in the female screws of the beaks. We shall consider the manner of using these instruments under the head of catheterism.

Fig. 36.

Besides the foregoing instruments, a supply of saddler's silk, and iron, lead, and silver suture wire, ought to be ready. To prevent them tangling, which they are exceedingly apt to do when kept in the skein or in bundles, they should be wound around a small piece of wood or ivory, similar to that seen in Fig. 36.

The pocket-case ought to be kept in perfect order and efficiency, the instruments should be carefully cleansed after every dressing or operation, and those having cutting edges not permitted to become dull.

CHAPTER II.

OF THE FIRST PIECES OF DRESSING.

Under this heading we propose to describe the kinds, qualities, and uses of certain articles which are usually placed in direct contact with diseased and injured surfaces, and therefrom called the "*first pieces of dressing*."

Lint is employed in surgical practice under three different forms—patent lint, charpie, and scraped lint.

Patent Lint is prepared by the manufacturer, and furnished the profession in the shape of rolls five yards long and fifteen inches wide. It may be described as a loosely-woven cloth of coarse hempen fibres, with one of its sides covered with a soft tomentose down; the other is harsh, and glazed by sizing. The lint is well adapted to the various purposes of a surgical dressing, being alone objectionable on account of its expensiveness. It is used as a direct application to wounded surfaces, either saturated with water, warm or cold, or spread with cerate. When intended to act as an absorbent, all greasy substances should be kept from it; but for this purpose it is not nearly so good as charpie. Cut into pieces of various shapes and sizes, patent lint possesses a wide range of application, as in the preparation of compresses, lining splints, as a vehicle for bringing water and medicated solutions in contact with the body, protecting ulcerated surfaces and absorbing their secretions.

Charpie is perhaps the best article now in use for dressing wounds, ulcers, and denudations. Like the preceding substance, a high price is asked for it by the manufacturers, by whom it is made in large quantities for surgical purposes. It may be easily prepared, as required by the surgeon, in the following manner: Take linen of moderate fineness, white, softened by use, and well washed, to free it from all impurities (bleaching preparations, such as chlorine and chlorinated lime, &c., should not be used to cleanse it); cut it into pieces three or four inches square; hold one of these in the left hand, and with the right ravel it, thread by thread, and throw them all in a heap. If the threads are too short, or too many of them are attempted to be removed at a time, the resulting charpie is apt to be knotty, and is illy fitted for contact with delicate surfaces.

A coarser and longer-threaded charpie may be made in a similar mode, and used for padding splints, as an outer dressing, and such like purposes.

When prepared in the way above directed, charpie forms a soft, light, and cottony mass, free from knots and unequal fibres. Viewed through a magnifying-glass, each thread is seen to be wavy, from the mutual pressure of the fibres by the crossing of the woof and warp, and is covered with little downy hooks which fasten into each other in every direction, holding the filaments lightly together.

Gerdy states that new linen makes a more absorbent charpie than old. This may be true, if he refers to very old cloth, whose fibres are both condensed and cleared of the cottony down above spoken of; but certainly that which is only softened by wear and washing is more porous, and preferable to stiff and harsh-fibred new linen for preparing a smooth and absorbing charpie.

With age, charpie changes color, becoming yellow, denser, and therefore less absorbent and more irritating than recent charpie. The material should be kept in a dry place, and out of the atmosphere of hospital wards rendered impure by the exhalations from diseased bodies, foul ulcers, gangrenous sores, or contagious diseases of every kind. Pelletan attributed the hospital gangrene which seized upon the wounds of a large number of the victims of the bloody days of

the French Revolution, lying in the Hôtel Dieu of Paris, to charpie so exposed and used in dressing their wounds.

Charpie is a gentle excitant of the surfaces to which it is applied, raises their temperature, and absorbs their secretions in a direct ratio with the thickness of the mass used. It takes up the serous portion of pus freely, and its globules less so; so that the side in contact with the pus will be found covered with the thickened secretion, while the outer surface is just moistened with the serum. The practice of smearing charpie with greasy matters materially interferes with, or entirely arrests, absorption.

For the purpose of answering special indications, the surgeon frequently arranges the fibres of the charpie in different manners, which we shall now describe.

The *Plumasseau* is thus formed: Hold a mass of charpie in the palm of the right hand; then, with the thumb and the radial border of the left, seize the ends of the fibres, and draw them out parallel upon its palmar aspect. Make the plumasseau from a quarter to an inch thick, according to the amount of secretion to be absorbed; then cut off the ends of the threads evenly, or fold them under. Its size and shape should vary with the dimensions and figure of the part to be covered; that is, it must be round, oval, square, or quadrangular, according to the requirements of the case. The plumasseau is either applied alone, spread with cerates, or saturated with water or some medicated solution. Some surgeons have impregnated the charpie with various gases—as chlorine, carbonic acid gas, &c.—and have used it in certain cases with supposed advantage.

The *Gateau* is nothing more than a large plumasseau, and is prepared in the same form; but being too large to lie upon the palm of the hand, the threads are drawn out upon a table, the ulnar border of the left hand being used to retain their ends. The gateau may be made more expeditiously by taking a mass of charpie in the two hands, and moulding it with the fingers in the desired shape. The gateau forms a large loose mass well fitted to constitute the upper layer of a dressing.

The *Bullet* is made by rolling charpie between the palms of the hands in balls varying in size from a pea to an egg, in proportion to the extent of the cavity to be filled. When the bullet is intended for the purpose of absorbing, it should be light and open-textured; and on the other hand, when for pressure, as to arrest hemorrhage, it should be made denser by hard rolling.

The *Roll* is prepared exactly in the same manner as the bullet, with the exception that it is given a spindle-shaped or cylindrical form, and sometimes slightly compressed. It varies in size according to the necessities of each particular case. The purposes which the roll serves are chiefly to separate abraded or ulcerated surfaces, as the thighs and nates in intertrigo, the thighs and scrotum, and the labia majora when they are ulcerated. It is used also to keep the lips of those wounds apart, that we do not desire to have healed.

The *Bourdonnet* consists of a number of threads rather firmly

rolled together between the palms, and tied together at their centre with a thread. It is used to make pressure at the bottom of wounds or cavities, and to keep the margins of any solution of continuity asunder. The free thread hangs externally, and enables the surgeon to remove the bourdonnet from its bed.

The *Pellet* is a mass of charpie inclosed in a piece of muslin, and tied at its upper part, so as to form a sort of stopper; or, again, the muslin may be introduced into any cavity, first, and then the lint stuffed in; thus, a very large space with a small orifice may be readily filled. The pellet is employed to make pressure in hemorrhage from the rectum and the intercostal and internal pudic arteries. We should be careful in removing the pellet not to pull it swollen by the absorption of blood, or the secretions from the wound, but rather to open the muslin bag, and with a pair of forceps pick out the lint piece by piece.

The Tampon.—When a number of separate masses of charpie are thrust into a cavity or wound to plug it up, either free or inclosed in a little pocket of linen, a tampon is formed. So that the pellet, bourdonnet, roll, and bullet are tampons on a small scale when they are employed to make pressure upon bleeding vessels. Uterine hemorrhage is sometimes treated by tamponing the vagina.

The Meche.—Place a few filaments of charpie parallel with each other, and tie them together at the centre with a thread, then double them, so that all the ends shall meet. It should be trimmed evenly, when you will have the *common meche.*

The *linen meche* consists of a strip of linen an inch wide, ravelled at its two lateral edges into a fringe a quarter of an inch wide.

The *cotton meche* is nothing more than the ordinary round lamp-wick.

The meche may be had recourse to for dilating fistulous passages and contracted orifices.

The Tent.—The tent is now scarcely ever used, being replaced by the much more elegant and convenient meche.

Should it be desired, however, it may be formed of charpie, an old piece of muslin, any porous root, the gentian or flag, for instance, or sponge.

If charpie is at hand, select a few fibres of it, and lay them parallel with each other; then double them to bring all the ends together, and give the cylinder a twist between the fingers so as to impress upon the fibres a spiral direction and a conical form; or a piece of soft old linen may be rolled into a cylinder of the desired size.

Gentian, carrot, and calamus roots, thoroughly dried, and cut into pieces of the proper size and shape, will answer the purposes of a tent.

SPONGE TENT is prepared by soaking soft white sponge in melted yellow wax, and then allowing it to cool under pressure between two marble or metallic slabs. The sponge may then be fashioned with a knife as desired.

Some surgeons prefer to these tents narrow strips of adhesive plaster rolled in little cylinders, or short pieces of a gum bougie or catheter.

The ordinary object in view in employing tents is to obtain a dilating effect by their swelling with the absorption of the heat and moisture of the parts; hence they have been used to dilate contracted orifices and narrowed canals. The objection to these is the painful pressure they sometimes exert, and the blocking in of secreted fluids. For procuring a gentle force, the tents made of charpie and old linen are to be preferred. Sponge tent acts energetically and often causes insupportable pain; it is sometimes used to dilate the os uteri.

Scraped Lint is the soft, fleecy, and light down scraped from the surface of old linen with a moderately dull knife. A piece of this kind of cloth should be stretched out upon a board, and its corners fastened down with tacks; or it may be held between the left hand of the surgeon and the hand of an assistant, while with his right he removes the lint with the edge of the knife.

Viewed with a double convex lens its fibres will be found fine, short, and sharp pointed, and, from these circumstances, it is more irritating than other kinds of lint, though more absorbent. This property renders it an appropriate dressing in those cases of flabby and indolent ulcers, or of other atonic secreting surfaces which require gentle stimulation.

In domestic practice, cuts and sores are sometimes dressed with the fine, soft down scraped from an old fur or silk hat; it absorbs their moisture and forms over them an impermeable crust under which the healing goes on by what Macartney called the "modelling process."

Cotton.—The softness, cheapness, and general diffusion of cotton have for a long time attracted the attention of surgeons, and induced them to apply it to many important surgical purposes.

Mayor, of Lausanne, states his belief that cotton may advantageously replace all kinds of lint, while, on the other hand, Gerdy condemns it in unmeasured terms, for all uses other than as an external part of dressings, and for padding splints. The truth seems to lie between these two extremes; for Velpeau and Larrey have employed it as a direct application with considerable success and satisfaction. Anderson, of Glasgow, lauds cotton highly as a dressing for burns; and Roux thought it formed an excellent covering for ulcers. Every surgeon will readily acknowledge its usefulness as an incomparable article out of which the softest and downiest cushions can be made for supporting an injured limb, and equalizing the pressure of splints.

Examined with a magnifier the fibres of cotton are seen to be long, rugged, and spirally twisted, interlacing with each other in every direction. It is quite absorbent, and more irritating than either patent lint or charpie, to which it is also now conceded to be inferior as an immediate dressing for wounds.

We have used cotton in bed-sores, by spreading sheets of it under the patient, and believe that a salutary influence is exercised upon their surfaces by its gently stimulating action. It has one objection, viz., a tendency, when soaked with the secretions from the sores, to roll up in hard and irritating knots, which cause great discomfort to a patient. However, it certainly ranks next to lint in value as a

dressing, and in the absence of the latter may serve as a substitute. It is invaluable for maintaining an elevated temperature in parts deprived of their vascular supply by the ligature of the main artery, or other causes.

Cotton is found in commerce ready for use, in sheets neatly rolled up in cylindrical bundles.

Oakum.—Lately this article has been much used in the treatment of suppurating gunshot wounds, and is particularly praised for this purpose by Dr. Sayers, of New York. He simply confines the oakum to the wounded part by a roller bandage. Seamen have for years been in the habit of employing it as a direct application to the wounds and injuries incidental to their calling.

Oakum is prepared by tearing old tarred rope into threads; the tar which permeates it confers stimulant, astringent, and antiseptic properties, and on account of the latter quality particularly, is preferable to tow in cases where the secretions are fetid.

The fibres of oakum are coarse, rough, and very unfriendly to sensitive granulating surfaces, and for this reason should generally be laid over a thin, interposing layer of charpie. It absorbs pus only moderately.

For use the oakum is moulded with the fingers, in the form of a gateau of the proper size to cover the wounded part, and retained in position by a few lightly applied turns of a roller.

Tow.—As an outer dressing to absorb profuse secretion and to level inequalities of the limbs for the application of splints, tow forms an excellent material. Its fibres are coarse, harsh, and irregular, which unfit them for the purposes to which lint is so admirably adapted. Various degrees of fineness are possessed by tow as found in commerce, the coarser varieties made from hemp should be rejected for the soft and elastic article prepared by the process of hatchelling flax.

Tow is employed in the form of gateau in the same manner as oakum.

Wool.—From its irritating qualities, comparative scarcity, cost, and general inadaptability for surgical dressings, wool can never take the precedence of any of the above-mentioned articles when obtainable; however, when wrought into cloth, its elasticity, and warmth-preserving properties highly recommend its application, in the form of rollers, to limbs suffering from defective circulation and nutrition, instead of muslin.

Raw Silk is here suggested rather as an attainable substitute for lint, tow, &c., in those countries where the article can be obtained both cheaply and abundantly, and in the absence of more appropriate materials. naval medical officers cruising in the East Indies can make this answer as a dressing. I used it in Japan; but the length, density, smoothness, and little absorbing power of its fibres did not recommend its continuance when a supply of other articles was on hand.

The same remarks apply to the downy substance enveloping the seeds of the silk-cotton tree, a large plant of the genus Bombyx growing both in the East and West Indies.

For padding splints I have made some trials with the cottony, or

rather silky matter (aigrette), attached to the seeds of the Asclepias Syriaca, or Milkweed, an herbaceous plant growing abundantly in the neglected fields throughout Pennsylvania. As it costs nothing, and answers as well as the finest cotton, the attention of rural practitioners ought to be drawn to the advantages which may be made to spring from its introduction into surgical practice.

It does not irritate wounds, and will, therefore, serve as a direct dressing; in experiments made by me to ascertain its absorbing power, I found it to be equal to that of raw cotton.

SPONGE is rarely used as a dressing, though the late Dr. Valentine Mott entertained a high opinion of its value as a powerful absorbent, and as a dressing in profuse suppurations and compound fractures. The compression obtained by binding large pieces to flaccid and uneven surfaces has been highly commended by several surgeons. Sponge is harsh textured, and not generally agreeable to the feelings of a patient. The granulations developed from the surface of ulcers, are apt to shoot into its pores, and thus render the removal of the dressing both injurious and painful.

MOSS.—A fine quality of moss, in emergencies, has been used as a dressing; and in countries where it grows abundantly upon the trunks and limbs of trees, as along the banks of the Mississippi River, it may be made available for filling up inequalities of the surface of the body, and for making soft cushions to be used in the treatment of fractures.

CAT'S-TAIL, OR TYPHA (Týpha latifolia).—Cat's-tail has been for a long time employed in domestic practice, in some parts of Europe, as a substitute for cotton in burns, ulcers, and wounds. It is prepared by beating the cylindrical tops of the flag against the edge of a board, whereby a soft and whitish brown, downy, porous matter is obtained. It absorbs readily, but the fibres are short and sharp, and often produce considerable irritation of the wound to which it is applied, and they adhere so tenaciously to them as to render their removal difficult.

The typha grows abundantly in the marshes throughout the Southern States, and is used by the country people for making beds and pillows. At the temporary naval hospital, located during the late war at the delta of the Mississippi River, where this flag grows in the greatest plenty, during a period of great scarcity of surgical dressings, soft pillows for fractured limbs to repose upon, pads for splints, and a variety of useful articles, were prepared from cat's-tail.

AMADOU (spunk, or punk).—Amadou and spunk are two porous, fungous vegetable growths, found adhering to, and deriving their support from the juices of the oak, birch, willow, and other trees, and have been at times highly commended as surgical dressings. Mr. Wetherfield (*Lond. Med. Gaz.*, 1841) states that the amadou or German tinder forms an excellent elastic medium for applying support and pressure, and as a defence to tender and delicate parts, as in the form of a graduated compress in umbilical hernia of new-born infants, and as a compress over fistulous ulcers of the groin. It does not lose its elasticity like lint. In preparing it we select such pieces as are firm, smooth, and of uniform density, cut them in slices, and then

by beating with a mallet render them soft and pliant. Recamier's plan of employing it in the treatment of cancer will be considered farther on.

Bran.—We are indebted to Dr. J. Rhea Barton, for the introduction of bran into surgical practice; he generally used it in compound fractures of the leg, but it may be made available in the treatment of wounds of the soft parts. It is an elegant, light, and cool dressing, and particularly useful in hot weather. The bran should be heaped up over the broken limb contained in a fracture box, so that the flies cannot deposit their ova in the wounds, and produce maggots.

Sawdust.—I have used moderately coarse pine sawdust with the most pleasing results, in the same manner as the bran, and think, after a considerable experience, that as a cool, cheap, and very absorbent article, we know of no substance superior to it for forming a bed upon which to rest profusely suppurating stumps. About a quart of the dust may be spread upon a square piece of muslin, the stump placed upon it, and the ends reflected over the limb and pinned together. In this manner one dressing will generally do for a whole day, no inconsiderable advantage in an overcrowded hospital, near the battle ground, or with a small number of medical officers, a condition of things not very uncommon during the late war.

Metallic Plates.—In the treatment of flabby ulcers, and wounds requiring some stimulation, metallic plates have been tried, particularly those of tin, or tin, antimony and lead, or simply lead, such as are to be found in tea-boxes. We obtain the advantages of compression, and of the chemical action of the soluble salts formed upon the surfaces of the plates, by the contact with the secretions. Doubtless the electrical currents, which are always developed by such combinations, may have a share in their beneficial influence.

The metallic plates are simply cut and bent into the appropriate size and shape of the surface to be covered, a layer of lint then placed over them to absorb the secretions, and the whole confined by turns of a roller bandage.

Compresses.—It will be useful to have square pieces of muslin, linen, and flannel at hand, for the purpose of making those compresses of various forms which the surgeon commonly avails himself of in dressing. For immediate contact with wounds, the material should be soft, and partially worn linen; flannel may be used in those cases where its properties of elasticity and absorbability are required. It will also be economical, and answer just as well, to employ muslin for equalizing the surfaces of parts, and where the skin is unbroken.

Besides these materials, raw cotton, tow, and other similar articles are sometimes made use of as compresses.

A compress answers other indications than mere compression, which its etymological import would seem to imply. It may be simply protective, as when we place a layer of soft linen between two opposing surfaces to get rid of the ill effects of friction, or cover a wound to shield it from external irritants; or to ward off the pressure of splints; again a compress may be said to be retentive only when it holds other dressings in place.

Compresses have been divided by Velpeau into three classes, the *simple*, the *split*, and the *folded*.

1. *Simple Compresses.*—The *square* or ordinary compress is formed by folding a piece of cloth, with a length of double its breadth, upon itself; all its sides are equal.

When the square is folded diagonally so as to bring two of its angles together, the *triangular* compress results; then by placing the apex of the latter upon its base, and folding once, the *cravat* compress is formed.

The square doubled once, gives the *oblong* compress, and this folded again, the "longuette" compress.

The *perforated compress* is prepared by piercing a piece of cloth with numerous holes, either with the points of the scissors, or a punch which removes small circular bits; the latter object may also be more conveniently and expeditiously accomplished with the edges of the scissors: holding the cloth in the left hand, and shoving up small folds with the point of the index finger, clip them off. This compress is usually spread with cerate to prevent other dressings adhering to the wound, and necessitating painful tractions for their removal. Another of its advantages is to allow the free emission of pus.

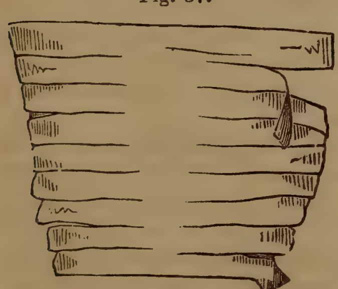
The *fenestrated compress* results from the cutting out of a piece of cloth, of an oval, square, or triangular shape near the centre of the muslin.

This is used, sometimes, to remove hurtful pressure from any part of the surface, as in burns and corns; to limit the action of caustics, and to dress certain ulcers.

When the square compress is twice folded, and the free angles removed in the direction of a curved line between the upper and lower angles, the round compress results, which may then be either perforated, fenestrated, or fringed, so as to allow its edges to adapt itself accurately to the irregular outlines of any part.

2. *Split Compresses* are formed by making slits in the sides, centre, on ends of strips of cloth of different widths and lengths. They are denominated the button-hole, the single-split, the double-split, the many-split, and sling-compresses, the half Maltese cross, and Maltese cross. The button-hole compress has simply a slit in its centre; the single-split, or compress with two tails, is a piece of muslin slit up from one end to its centre; the double-split, as its name indicates, is divided in the same manner by two slits, into three tails. The two latter compresses are more commonly called *retractors*, and are used almost exclusively in amputations to press back the soft parts while the bones are being sawed through; the former when the limb has a single bone, and the latter compress when there are two bones. The many-split compress is prepared by slitting the two sides of a piece of muslin into a

Fig. 37.



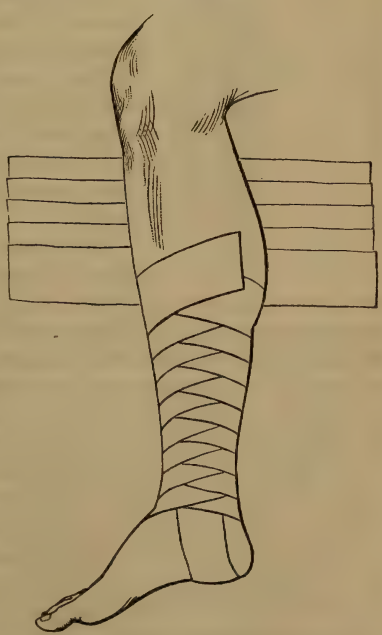
The many-tailed bandage.

number of tails (Fig. 37), leaving an intermediate uncut portion or body. A modification of this is what is known as the bandage of Scultetus, consisting of separate strips overlapping each other a half or two-thirds of their width. When these strips are tacked together with thread and needle along their middle, Pott's bandage is formed.

The *eighteen-tailed* bandage, so called by Verduc, consists of three pieces of muslin, equal in size and of the desired width, laid one upon another and fastened along the centre with thread and needle; then with the scissors each of its two sides is split into three tails. The many-tailed bandage employed by Dupuytren was made of nine separate strips, sewed together at their centre, after having been imbricated in the usual manner.

These different forms of the many-tailed bandage have been chiefly employed in making compression upon the limbs after having been fractured, and before the application of the other portions of the dressing; although, in many other cases, they will be found exceedingly neat and convenient to retain poultices, or other dressings upon diseased or injured extremities. The bandage of Scultetus is particularly adapted to this purpose, for the reason that any portion of it, when soiled, may be removed without disturbing the rest. Their mode of application is the same, viz: to spread the bandage out upon the bed, and then to lay the limb upon it and bring up the strips alternately from side to side, imbricating them smoothly, until the leg, or whatever part it may be, is covered in.

Fig. 38.



Application of the bandage of Scultetus.

When applied moist for the purpose of making compression, the surgeon cannot watch them too narrowly; for the most disastrous consequences have, on several occasions, resulted from their producing excessive constriction, either by the subsequent swelling of the parts on which they are placed, or by the contraction of the bandage itself, or both causes combined.

The *sling-compress* is a long strip of muslin or other material, divided from each of its extremities to within three or four inches of the centre.

It is principally used in the treatment of fractures of the lower jaw, and for confining dressings to the joints.

The *half Maltese cross* is formed by folding a square compress upon itself, and cutting with the scissors diagonally from either of the corners formed by the free angles, towards the centre of the opposite folded side.

The half Maltese cross is sometimes employed to retain dressings upon the shoulder after amputation.

The *Maltese cross* (Fig. 39), in like manner, may be made from a square compress folded twice upon itself in opposite directions, by cutting diagonally from the corner where all the free angles meet, towards the opposite folded angle and within a short distance of it.

Fig. 39.

The Maltese cross.

This compress is had recourse to as a retentive of other dressings upon stumps after amputation, and also upon the mamma.

The *fringed compress* is a slip of linen from a few lines to an inch in width, incised upon one border only into a sort of fringe. It is spread with cerate, and applied to the circumference of wounds, with its points outwards to prevent the charpie, lint, or other dressings adhering to them.

3. *Folded compresses* are prepared by folding layer after layer of lint, muslin, or linen upon each other in different manners.

When these folds are of equal width, it is called the *regular graduated compress;* when, on the contrary, the folds are shortened upon one side, the *single graduated compress* (Fig. 40) results; and when the folds gradually diminish in width upon both sides, we obtain the *double graduated compress* (Fig. 41).

Fig. 40. Fig. 41.

Folded compresses.

The *pyramidal compress* is made by piling up square pieces of any kind of cloth upon each other, each being smaller than its predecessor, until a sufficient thickness is obtained. If these pieces are round, the compress will of course be conical.

These compresses are useful when firm pressure is required either over a given point, line, or limited area; as, for instance, to restrain hemorrhage from the temporal and brachial arteries after being wounded in the operation of bleeding, or from the arteries of the palmar arch; to exercise compression upon morbid growths, aneurisms, and along the course of fistulous canals, or over abnormal cavities; and to force from their nidus pus or other diseased secretions.

Often for the purpose of retaining dressings upon the body, confining fracture apparatus, securing the limbs of patients about to undergo certain surgical operations, such as lithotomy, threads, cords, straps, and strips of muslin are employed by the surgeon. They will be considered in their appropriate places, throughout this work, in connection with the bandages, apparatus, instruments, and surgical procedures to which they specially appertain.

Bandages are secured by means of pins and threads; and as the latter are connected together by knots, some of which are in frequent use by the surgeon, it may not be inappropriate to give figures of them.

The *surgeon's knot* is seen in Fig. 42, and was formerly employed when a thread was tied around an artery. The *single bow knot* (Fig.

Fig. 42.

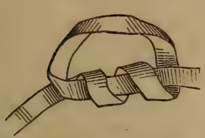


Fig. 43.

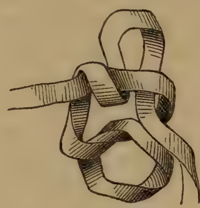
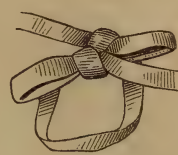


Fig. 44.



43) and the *double bow knot* (Fig. 44) are in constant use for fastening the muslin strips around fracture apparatus, and the threads securing the little bandages about the fingers and toes. The *single knot* (Fig. 45) and the *double knot* (Fig. 46) are used for like purposes.

Fig. 45.

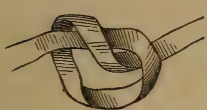


Fig. 46.

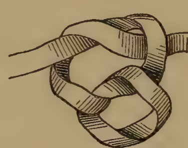
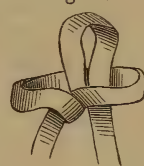


Fig. 47.



The *loop knot* (Fig. 47) will answer to arrest the venous circulation during venesection, and enables the operator to graduate the compression instantly and accurately.

The *packer's knot* (Fig. 48) is the one formed over the temple by the knotted bandage of the head.

The *clove hitch* (Fig. 49), used in applying the extending bands for

Fig. 48.

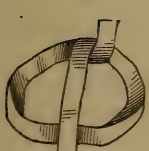


Fig. 49.

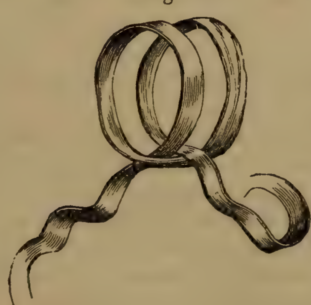
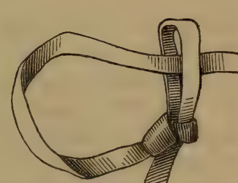


Fig. 50.



the reduction of dislocations, consists, as seen in the figure, of two packer's knots laid together.

The *single noose* (Fig. 50) and *double noose* (Fig. 51) are employed by the surgeon to secure the hands and feet of a patient about to undergo the operation of lithotomy.

The *reef* or *sailor's knot* (Fig. 52) is the one mostly used by surgeons of the present day for ligaturing arteries instead of the surgeon's knot,

for the reason of its less liability to slip, and the certainty with which it closes the arterial canal. The case of Chopart, as related by Boyer,

Fig. 51.

Fig. 52.

Fig. 53.

is well known: that distinguished surgeon lost a patient from hemorrhage, in operating for popliteal aneurism, after three ligatures had been placed upon the artery and tied with the surgeon's knot. An examination showed the vessel to be healthy, but not closed by either of the knots.

Fig. 53 shows the *weaver's knot;* Figs. 54 and 55 are forms of the

Fig. 54.

Fig. 55.

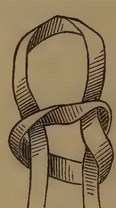


Fig. 56.

Fig. 57.

simple slip knot; Figs. 56 and 57 are the *double-knotted and looped,* and the *crossed slip-knots.*

Adhesive Plaster.—This article is of the utmost importance to the surgeon, being constantly in demand for the treatment of various diseases and injuries which are always presenting themselves in the daily routine of practice. It is now supplied the profession by manufacturing druggists in rolled sheets ten yards long and sixteen inches wide. The mode of preparation consists in spreading, by means of machinery, the emplastrum resinæ of the Pharmacopœia (a compound of lead plaster and resin in the proportion of six parts of the former to one of the latter) upon sheets of muslin or linen.

Ordinarily the plaster is employed in strips, yet for special purposes it may be cut with the scissors into any shape that may be demanded. The strips should be severed evenly and smoothly, and, to attain this object, the best plan will be to unroll the sheet to the extent required by the length of the strips, and stretch it, by an assistant taking charge

of the roll, and the surgeon of its free end with the left hand, in such a manner that the thumb and index finger support the extremity of the strip, while the middle and index fingers uphold that part of the sheet beyond. Then with the scissors make a small cut into the border of the plaster, between the fingers, and holding their blades half open, press them along the cloth towards the assistant.

Although it is customary, when the roll is sufficiently ample, to cut the plaster crosswise, or in the woof, yet it is always preferable to follow the warp, or the large threads running lengthwise, for the reason that strips prepared in the latter way yield less to an extending force, and in a more uniform manner. In fact, where there is much resistance expected they should be made in no other way.

The strips thus provided, to prevent any giving, ought to be separately stretched before being applied, and then warmed to enable them to adhere immediately to the skin. A moderately long and narrow strip may be sufficiently warmed by drawing it rapidly through the fingers. The flame of a candle will answer the same purpose, but the strip is apt to be blackened by the carbonaceous matters of the flame. The neatest, best, and most convenient plan of all is to soften the plaster by applying, for a few moments, the backs of the strips to a tin vessel filled with hot water.

Adhesive plaster is adapted to a great variety of cases, and serves many useful purposes; among others, to retain dressings, splints, lint, and compresses upon the surface; to make compression, and to exercise a slightly stimulating effect upon ulcers of the extremities, chronic swellings of the joints, and upon indolent tumors; sometimes it forms the whole of the retentive apparatus in certain fractures.

The stimulating effects of ordinary plaster sometimes render it an objectionable dressing in fresh wounds, and where the integuments are exceedingly sensitive, as they occasionally are; under such circumstances it may induce erythema, or even erysipelas. To obviate, in a measure, the irritation, Mr. Baynton employed a plaster containing only six drachms of resin to the pound of lead-plaster. With the same view, M. Herpin recommends the addition of the tannate of lead, the proportion of which should not exceed one-twentieth.

When properly made, and fit for surgical use, the plaster should not crack or drop off the muslin in flakes, or adhere to the skin when the strips are removed. The plaster may be rendered more pliable, and prevented from cracking in very cold weather, by the addition of a small proportion of soap, which is far preferable to those cheaper and more irritating articles, sometimes added for this purpose, Burgundy pitch and oil of turpentine.

An adhesive plaster, prepared with the latter substance, was once supplied a hospital under my charge during the late war; and after three or four trials I was compelled to abandon its use in consequence of its irritating qualities. As age diminishes its adhesiveness, the supply should often be replenished.

After the strips have been removed the surface may be cleared from all adhering matters with a sponge moistened with the oil of turpen-

tine, and when the oil has been cleared off by castile soap and water, the parts may be dried with a soft towel.

Isinglass Plaster was brought into notice by Mr. Liston, who says: "Of late, I have greatly dispensed with stitches and the common adhesive plaster, using, instead of the latter, slips of glazed ribbon smeared with a saturated solution of isinglass in brandy, which is much less irritating and more tenacious than the common adhesive compost."

Subsequently, for the ribbon he substituted the peritoneal covering of the cæcum of the ox, rubbed down and polished.

As now found in the shops it is in rolled sheets, three yards long and eight inches wide. Should the surgeon desire to make it himself, the following is the formula. Moisten one ounce of pure isinglass (the dried swimming bladder of several species of fish belonging to the genus Acipenser) with two ounces of water, and permit it to stand until it is quite soft; then add three and a half ounces of rectified spirits, previously mixed with one and a half ounce of water. Place the vessel in boiling water until the solution is complete, and about the consistence of jelly, when it is ready for use. Now spread the oiled silk upon a table, tack down its ends, and with a brush apply the solution to its surface; when this is dry, another coat may be laid on and permitted to dry. The plaster is then fit for use.

The advantages claimed for it are that it is unirritating; possessing some degree of translucency, the parts beneath may be always inspected, and finally, it does not soften in extremely warm weather. The latter quality will render it a valuable article to the naval surgeon cruising in hot climates. The drawback to its general use will be the facility with which it is loosened by the contact of the warm secretions of the parts to which it is applied.

The mode of using it is to cut the plaster in strips, and, after moistening their gummed sides with a sponge squeezed out of hot water, lay them on as you would the ordinary adhesive strips.

Collodion.—This was first suggested as an agglutinative by Mr. Maynard, of Boston, a medical student. It is a solution obtained by dissolving gun-cotton, on pyroxylin, in a mixture of rectified ether and alcohol, in the proportion of about 16 parts of the former to one of the latter.

When applied to the surface it produces a sensation of coolness by the evaporation of the ether, and leaves behind a translucent, contractile, and adhesive film. To prevent the puckering up of the skin, which follows the application of the collodion, it has been suggested that one part of the oil of turpentine be added to every twenty of ether. Guersent, with the same view of conferring the desirable properties of softness and elasticity upon collodion, recommended the addition of castor oil in the proportion of two parts to thirty of the former.

It is used to approximate the edges of wounds, to close the eyelids after operations upon the eyes, and as a compressing agent in discussing indolent buboes and chronic tumors.

Mr. Latour has proposed the following formula for the treatment of

superficial inflammations: Collodion, 46 grains; Venice turpentine, 23 grains; castor oil, 8 grains. This is to be applied over the whole of the diseased surface. His theory is, that the contact of the air is an indispensable element in calorification, and he seeks, therefore, to shield the inflamed part with an impenetrable coating of three or four layers of collodion, put on with a camel's hair brush. A similar application is also used with great success, rarely irritating the skin: Collodion, 30 parts; old castor oil, 2 parts.

Either of these dressings is easily detached by a linseed poultice.

M. Arran, observing the utility of the salts of iron in erysipelas, in order to facilitate their application, combined them with collodion, forming a preparation which united the compressive and astringent effects. It consists of equal parts of collodion and ethereal tincture of perchloride of iron. It is more supple and resisting than the ordinary film of collodion, and adheres more tenaciously than it to the skin.

M. Valette, of Lyons, believes it to be a powerful hemostatic, and Mr. J. H. Tucker effectually controlled the hemorrhage from leech-bites with it.

The mode of application is simple. The collodion is placed upon the skin, previously carefully cleansed and dried, with a camel's hair brush; or, if a firmer bond of union is required than can be obtained by the collodial film, a piece of lint or a few threads of charpie soaked in the solution may be laid over the wound.

Chloropercha is similar in its properties to collodion, and is prepared by dissolving gutta-percha in chloroform.

WATER-GLASS.—Küchenmeister has recently introduced to the notice of the profession a new adhesive compound which he states will form an impermeable film, as well as modify the vital action by virtue of its alkalinity. His formula is the following: powdered quartz 15 parts; caustic potassa 10 parts; charcoal 1 part. Mix and melt them together, and then add to the mixture after cooling five pints of water, and boil the liquid to a syrupy consistence, when it is ready for use.

Dr. Miller, as a succedaneum for collodion, proposes a solution of shellac in highly rectified alcohol so as to have a gelatinous consistence.

An agglutinative may be extemporized by mixing flour and white of eggs into a paste, and spreading this upon strips of muslin or linen.

"STYPTIC COLLOID."—Mr. B. W. Richardson, of London, has recently called attention to the advantages of a compound fluid for instant and ready use in dressing wounded surfaces, which he has designated as "styptic colloid."

It is prepared by digesting in absolute alcohol for several days the purest tannin that can be obtained; then absolute ether is added until the whole of the thick alcoholic mixture is rendered quite fluid; xyloidine, or gun-cotton, is put in next until it ceases to be readily dissolved, and to confer an agreeable odor upon the mixture a little tincture of benzoin is finally added.

The solution is now ready for use and can be applied either with a

brush, or mixed with an equal quantity of ether; it can be used in the form of spray.

The "styptic colloid" acts by the tannin in its composition entering into combination with the albumen of the blood or secretions of the wound or sore, forming an impermeable coating upon the part under which the healing process may go on much in the same manner as it does in subcutaneous wounds.

As to the mode of applying the fluid it is sufficiently simple; supposing the case to be one of an open wound, the two flaps of an amputation, for instance, the parts should be brought together and sustained by four or five fine sutures. In a wineglass tease out finely a little cotton wool and saturate it with the styptic solution; apply this solution with a camel's hair brush over the surface of the closed wound, letting it lie between its edges. Next take the cotton up with a pair of forceps and lay a seam of it half an inch wide and the eighth of an inch in thickness over the line of the incision. Upon this another layer of the solution is put, and when dry cover it with a little dry cotton, and finally secure the whole with a roller bandage.

The "styptic colloid" may be used as a dressing in recent wounds, hemorrhages, ulcers, cancerous sores, &c.

"In no case," observes Mr. Richardson, "need there be any fear that irritation will follow the application of the solution, on the contrary, the action of it is so purely negative that it might be considered a sedative. It is not such in the technical sense of the term, but it so effectually covers the wounded and susceptible surfaces as to maintain what is virtually a sedative influence:" though in wounds to be closed by first intention it is not good to leave the styptic in large quantities between their margins, as it sometimes produces friction and so causes evolution of heat and pain.

In small wounds one dressing will be all that is necessary, and the styptic film will be thrown off in the process of cure. Even in larger wounds it will be advisable to leave the dressing undisturbed until the parts are thoroughly healed, unless for some urgent reason.

As the dressing is insoluble in water either hot or cold, that fluid should not be employed in its removal, but a mixture of alcohol and ether, or equal parts of absolute alcohol and distilled water, warmed a little above the temperature of the body.

Besides this simple form of "styptic colloid" this fluid combines well with other medicinal substances; with creasote it forms a compound more decidedly antiseptic, and aids in solidifying the albumen more thoroughly; it produces, however, some degree of irritation. The proportion is one minim of creasote to two drachms of the solution.

Carbolic acid acts similarly to the creasote, and may be combined in the proportion of five grains of the acid to two drachms of the "styptic colloid."

Where there are purulent or fetid discharges from a surface surrounded with indurated tissue, iodine may be added with decided advantage; from five to seven grains may be got into a quarter-ounce of the solution. The iodine produces no irritation.

The compounds of iodine, as the iodide of cadmium, potassium and

ammonium, the bichloride of mercury and the chloride of zinc are also taken up by the styptic fluid.

Morphia and the other narcotic alkaloids are soluble in the fluid, and either of them may be used according to the indications presented.

Two to four grains of cantharidine, dissolved with the aid of a little chloroform in a fluidounce of the liquid, will furnish an epispastic compound.

THE SURGICAL TRAY.—For convenience, in the daily routine of duty, the surgeon having charge of the surgical service of a military or civil hospital, generally brings together, in what is called the "surgical tray," certain instruments and dressings, which he may be called upon to use at any moment.

The one employed by me was a simple tray 2½ feet long, 20 inches wide, and 3 inches deep, divided into compartments of different sizes, and containing a number of roller bandages of various lengths, several kinds of compresses, pieces of muslin and linen, towels, adhesive strips, lint, charpie and ligatures; other divisions received the pocket case, catheters, bougies, and pin-cushion. Three cups were neatly fixed in one end for holding a small quantity of whiskey, turpentine, and sweet oil. A quantity of fine sponges and a bottle of camphorated tincture of soap completed the supply. A brass hoop, spanning the tray from side to side, served the purpose of a handle.

THE SURGICAL WALLET.—As medical officers of the navy were called upon, during the late war, occasionally to leave their ships with boat expeditions on the coast, or up the narrow rivers of the South, it became necessary to have certain instruments and dressings arranged in a compact form for transportation, inasmuch as the instruments allowed to ships-of-war are injudiciously crowded into one unwieldy case, which it would not be desirable to risk, by loss of the boats, or any other casualty, and thus deprive them, perhaps, of every surgical instrument by a single unforeseen accident.

The boats, also, on such occasions, are generally crowded, and, therefore, very awkward places for a heavy and bulky surgical case.

Having felt the need of such an arrangement, I had a surgical wallet constructed, consisting of a piece of strong leather three feet long and fourteen inches wide, folding up like the ordinary pocket case, and containing the following articles: two pint-flasks, with screw caps similar to the pocket-flask, the one containing chloroform and the other brandy; a half pint flask of aqua ammonia; a square block of wood excavated upon its surface to receive an amputating knife, a small saw, and a pair of bone forceps, one movable handle answering for the former instruments; three screws and six field tourniquets; twelve roller bandages; four yards of muslin, a lot of Maltese crosses, and other compresses; six yards of adhesive plaster; twelve short splints; one box of simple cerate; and the pocket-case. When the wallet is rolled up, a strap is hooked to both of its ends, by which it can be slung over the shoulders or carried in the hand.

Every ship-of-war should be provided with such a wallet, ready at any moment for transportation, should the surgeon be called to render assistance at a distance.

CHAPTER III.

ON THE USE OF SOME TOPICAL REMEDIES.

THE remedies now to be described are applied either to the skin, or to the mucous membranes continuous with it, and lining the entrances of the several interior cavities.

They act either locally upon the parts to which they are applied, or are absorbed, and exert an influence upon the economy at large. In the latter instance, the remedy may either be brought into contact with the epidermis, or, this being removed, with the dermis; or, again, with the cellular tissue beneath the skin, by hypodermic injection.

This wide range of application of these topical remedies will at once, suggest and justly, too, that they are both numerous and capable of being employed in a great variety of forms and combinations; and it will be our endeavor in this place to consider as many of these as are in daily use and of real practical value.

CERATES.—"These are unctuous substances, consisting of oil or lard mixed with wax, spermaceti, or resin, to which various medicaments are frequently added. Their consistence, which is intermediate between that of ointments and of plasters, is such that they may be spread at ordinary temperatures upon linen, by means of a spatula, and do not melt or run when applied to the skin." (*U. S. D.*)

The simple cerate of the Pharmacopœia, consisting of lard and white wax, is the one most commonly used in the treatment of surgical diseases, and when spread upon linen, constitutes what is known under the name of "the simple dressing."

When applied to wounds, it should be smeared sparingly upon the fringed or perforated compresses, for too much will convert a very cleanly dressing into a very uncleanly one; the fatty matter which clings in crusts to the margins of the sores becoming rancid and irritating.

Should charpie or lint be intended to act as absorbents, a perforated and cerated piece of linen may be interposed between them and the secreting surface, for these materials themselves, covered with greasy matter, are but indifferent absorbents.

If it is desired to obtain the stimulating effects of the charpie, as well as the absorbent, it may be placed in direct contact with the wound which has its edges previously protected by the greased fringed compress.

Simple cerate is sometimes employed with frictions, to soften the skin, and to render parts more supple, in such cases as stiffened joints, contracted tendons, and rigidity of the integuments.

Its bland qualities recommend it, when spread upon soft linen, as an application to surfaces subjected to pressure, or excoriated. Such cases we meet with in patients confined for a long time upon their

backs in consequence of fractures of the bones of the spine and lower extremities, and in whom the shoulders, buttocks, and sacrum often become extremely tender.

To the cerate, opium, belladonna, iodine, iodide of potassium, or other active medicaments are occasionally added to answer special indications. Combined with the solution of the subacetate of lead, it is much used in the treatment of burns and scalds, and the ulcers left by blisters.

The cerate thus modified by these combinations may be applied, spread upon linen, or rubbed into the part with the hand, the latter plan being adopted if the object is to obtain the resolutions of chronic enlargements of the joints, or of glandular swellings.

Cerates should be perfectly bland and sweet; by long keeping they are apt to become rancid and extremely irritating. It has been recommended to use rancid cerate as a dressing for flabby granulating sores needing stimulation.

The following formulæ for extemporaneous cerates will be found useful by the practitioner:—

℞.—Calaminæ præp. ʒiij;
Camphoræ gr. x;
Cerati simplicis ℥ij. Misce.

This is a mild astringent and stimulant, and may be used in superficial ulcerations produced by burns, acrid secretions, chafing, or other causes.

℞.—Cerati plumbi subacetatis,
Cerati simplicis, āā ℥ss;
Hydrarg. chlo. mit.,
Pulv. opii, āā ʒj. Misce.

Used in excoriations, ulcers, burns, scalds, chilblains, and chancres. (Dr. Parrish.)

℞.—Resinæ ℥j;
Ceræ flavæ ℥ij;
Adipis ℥ij. Misce.

For burns. (Dr. Physick.)

℞.—Hydrarg. præcip. albi ʒij;
Cerat. simpl. ℥j. Misce.

A valuable application in venereal ulcers, porrigo, and other cutaneous diseases.

℞.—Hydrarg. nitrico-oxidi ʒj;
Cerat. simpl. ℥j. Misce.

A common application to ulcers and sores in general.

℞.—Unguenti hydrarg. nitr. ʒj;
Cerat. simpl. ℥ss. Misce.

A celebrated application to the edges of the eyelids in chronic ophthalmia and opacities of the cornea; it is used also as a dressing for ulcers and sore nipples.

℞.—Unguenti hydrarg.,
Cerat. saponis, āā ℥j;
Camphoræ ℈ij. Misce.

For discussing hardness of the tissues and indurated swellings, and when rubbed along the course of the urethra relieves chordee.

℞.—Cerati resinæ comp. ℥j (Deshler's salve);
Adipis ʒij. Misce.

For healing ulcers following burns.

℞.—Ceræ albæ ℥iv;
Olei olivæ ℥j;
Aceti destillati f℥ij. Misce.

Used for superficial ulcerations and cutaneous eruptions. (Dr. Cheston.)

℞.—Acid. hydrocyanic. gtt. xx;
Cerat. simpl. ℥ij. M. ft. cerat.

For papular eruptions attended with itching. (Dr. Sargent.)

℞.—Creasoti gtt. xx;
Cerati simpl. ℥ij;
Zinci oxidi ʒj. M. ft. cerat.

For scaly eruptions. (Dr. Sargent.)

Ointments.—"These are fatty substances, softer than cerates, of a consistence like that of butter, and such that they may be readily applied to the skin by inunction." (*U. S. D.*)

All of the officinal ointments, with the exceptions of the spermaceti and simple ointments, are combined with more or less active and irritating medicaments. Before incorporating these with the fatty matter, they should be in the finest state of subdivision.

These preparations, like cerates, by time and a high temperature are apt to undergo chemical change and become rancid; and hence it is always better to prepare them in such quantities as immediate exigencies demand. It should be known, however, that this tendency to rancidity may be corrected to a considerable degree by the addition to the ointment of a small quantity of benzoin, poplar buds, or slippery-elm bark. To correct the fatty odor Dr. Geisler recommends ten drops of nitric ether to each ounce of the compound.

The simple ointment as well as that containing spermaceti is emollient, and serves as a mild dressing for blistered surfaces, excoriations from whatever causes, and wounds; but their principal use is to form a basis for more active medicaments. Of these we may mention the unguentum antimonii, which acts as a very efficient suppurative counter-irritant when rubbed upon the skin; this may be done twice a day or oftener, according to the effect produced. The skin should be unbroken, as the contact of the ointment with an excoriated surface sometimes produces an unpleasant degree of inflammation, and, in rare cases, even gangrene.

The strength of the ointment should vary according to the sensibility of the skin and the degree of effect desired: the officinal preparation contains two drachms of the tartar emetic to an ounce of lard, though the quantity may be increased to three drachms when a speedy action is necessary. The eruptive effects of this drug may also be obtained by sprinkling a strong solution of the powder upon adhesive plaster applied to the skin.

The mezereon and elemi ointments are also irritant, and are used as stimulating applications to sustain the discharge from a blistered surface, issue, or seton, and in obstinate, ill-conditioned, and indolent ulcers. The ointment of Spanish flies is used for the same purpose.

Creasote ointment has been highly extolled as a dressing for skin diseases, and especially those of a scaly character. In chilblains it will often relieve the annoying sense of heat and itching like a charm.

Among the astringent ointments are those of the acetate and carbonate of lead, forming invaluable dressings in burns, inflamed blisters, and excoriated surfaces.

The gall ointments, simple and compound, are now chiefly employed in cases of inflamed piles and prolapsus ani.

The unguent of the subacetate of copper forms a mild escharotic in fungous granulations; and, diluted with lard, is a good stimulant to foul and flabby ulcers, scrofulous ulcerations of the edges of the eyelids, chronic otitis, to warts and corns, and to several forms of cutaneous eruptions.

Mercurial ointment stands at the head of the alterative class of unguents, and is regarded as a good resolvent of indolent buboes, chronic glandular enlargements, and certain venereal nodosities of the bones and soft textures.

To affect the economy to the extent of ptyalism, it is used by inunction, about a drachm of the ointment being rubbed into the skin upon the inner aspect of the thighs, legs, or arms, morning and night, until the result is obtained.

It has been highly extolled for preventing the pitting of the pustules of smallpox; the ointment may be spread upon the inner surface of a mask made of leather or adhesive plaster. The ammoniated mercurial unguent is an excellent application to many skin diseases, as itch, herpes, and porrigo. Ointments containing the red oxide, the nitrate, the green, and red iodides of mercury, are also valuable preparations in dressing scrofulous ulcers, indolent sores from any cause, chronic ophthalmias, and various cuticular affections, and especially porrigo of the scalp.

The application of the ointment of iodine with a camel's hair brush, morning and night, to the swollen tonsils after the disappearance of inflammation, will, it is stated, reduce them in two months.

The combination of iodine and iodide of potassium is frequently employed in the form of an ointment to resolve goitrous and scrofulous tumors, and for the cure of certain varieties of obstinate skin diseases.

The almost specific effects of those preparations containing sulphur in the cure of itch, crusta lactea, and tinea capitis are well known. Ointments of white hellebore, tobacco, tar, pitch, and the cocculus indicus, may be also had recourse to as a dressing for chronic cutaneous eruptions with great advantage.

The most frequently employed sedative ointments are those containing belladonna, conium, or stramonium, and are useful in many cases of irritable or painful ulcers, inflamed piles, and skin affections.

In using any of the above compounds containing the salts of lead, the possibility of colica pictonum and paralysis occurring should be borne in mind. We should also carefully guard against producing the constitutional effects of the tobacco and the white hellebore entering into the composition of some of the ointments.

The following formulæ will illustrate some of the usual forms of extemporaneous ointments, and at the same time furnish useful combinations for the treatment of various surgical diseases:—

℞.—Zinci oxidi ʒj ;
Adipis ℥j. Misce.

An astringent application in common use.

℞.—Morphiæ acetat. gr. vj ;
Pulv. gallarum ʒj ;
Unguent. stramonii ℥j. M. ft. unguent.

For hemorrhoids. (Harlan.)

℞.—Tincturæ opii fʒj ;
Adipis ℥ij. Misce.

Used in painful and irritable sores. (Ricord.)

℞.—Plumbi iodidi ℈ij ;
Adipis ℥j. Misce.

This is very useful to stimulate an indolent or fungous venereal sore. (Ricord.)

℞.—Potassæ carb. ℥ss ;
Aquæ rosæ f℥j ;
Hydrarg. sulph. rubr. ℥ ;
Ol. bergam. f℥ss ;
Fl. sulphuris,
Adipis, āā ℥ix. M. ft. unguent.

Aromatic sulphur ointment for itch. (Bateman.)

℞.—Hyd. subsulphat. ℈ss ;
Unguent. cetacei ℥ss. M. ft. unguent.

Ointment for skin affections. (Acton.)

℞.—Picis liquid. f℥j ;
Butyri salsi ℥ij ;
Liquefac. unâ dein adde
Potass. impur. ℥j.

Gräfe's itch ointment.

℞.—Chlorid. hydrarg. corros. gr. j ;
Camphoræ pulv. ℈j ;
Cerat. simp. ℥j. Misce.

This is very useful to stimulate an indolent or fungous venereal sore. (Frestel.)

℞ —Unguenti hydrarg. ʒij ;
Extracti belladonnæ ʒiij. Misce.

For the resolution of lymphatic engorgements. (Velpeau.)

℞.—Ammoniæ muriatis ℈iij ;
Unguenti hydrarg. mitis ℥iij. Misce.

Use in scrofulous tumors, traumatic exostoses, and swellings of the bursæ. (Dupuytren.)

℞.—Hydrarg. oxidi rubr. gr. v ;
Cadmii sulphat. gr. iv ;
Adipis ℥ss. Misce.

Used in chronic ophthalmia and nebulous cornea. (Sichel.)

℞.—Extracti belladonnæ ʒij ;
Aquæ f℥ij ;
Adipis ℥ij. Misce.

Used to dilate the pupil, and the os uteri. (Chaussier.)

℞ —Unguenti hydrarg. fort. ℥j;
Antimonii et potass. tart. ʒj;
Iodinii gr. x–xv. Misce.

For chronic glandular tumors, old indurated buboes, &c. (H. Johnson.)

℞.—Potassii cyanidi gr. ij;
Adipis ℥ss. Misce.

An excellent application for pruritus vulvæ, and to relieve the itching of cutaneous eruptions.

Plasters.—"These are solid compounds intended for external application, adhesive at the temperature of the human body, and of such consistence as to render the aid of heat necessary in spreading them. Most of these have as their basis a compound of olive oil and litharge, constituting the emplastrum plumbi of the U. S. Pharmacopœia." (*U. S. D.*)

In the preparation of plasters, care should be taken not to employ any degree of heat that would alter their composition, or drive off any volatile ingredient upon which their efficacy may depend. As the action of the air alters the color and consistence of plasters, they are usually found in the shops in cylindrical rolls carefully wrapped in paper.

When freshly made, the plaster can be easily spread with a moderately heated spatula, and it remains soft, pliable, and adhesive.

To use it as a dressing the material is thinly spread upon leather or linen; the former being generally preferred when the application is to be made upon the sound skin, and the latter when upon excoriated surfaces, or to bring the edges of a wound together. The following is an excellent plan for obtaining a neat plaster. Take a piece of sheepskin, or some textile fabric of the proper size and shape, place upon its margins strips of adhesive plaster a half inch wide; then, with a gently heated spatula, the roll of plaster is melted and evenly spread. When the strips are removed, a clean border will remain, which will prevent the patient's clothes being soiled, and at the same time enable the dresser to seize it at any point for removal.

All plasters are more or less irritating, and when applied to the skin, they soften it, and prevent the insensible perspiration from escaping, thus keeping up a continuous local bath, to which, doubtless, some of their good effects are attributable. In persons with very sensitive skins, the irritation they occasion is sometimes so annoying as to preclude their use; even inflammation and erysipelas have been occasionally observed to follow their employment.

As gentle excitants in chronic articular diseases, scrofulous tumors, and indurations of the tissues from various causes, plasters of Burgundy pitch, of iron, of galbanum, and of ammoniac often serve a good purpose.

That of ammoniac is sometimes combined with mercury, and resembles in its properties somewhat the emplastrum de Vigo cum mercurio, so frequently employed by the French surgeons, and the formula of which is: Lead plaster two pounds eight ounces; yellow wax two ounces; resin two ounces; bdellium, olibanum and myrrh, of each five

drachms; saffron two drachms; mercury twelve ounces; turpentine two ounces; liquid storax six ounces; and oil of lavender two drachms. Melt the plaster, wax, and resin together, and add to the mixture the other materials. The plaster may be spread upon leather or linen.

No dressing has been more highly praised than this as an application to the face, to prevent the pitting of the pustules of smallpox; it is used in the same manner as mercurial ointment, smeared upon the inner surface of a mask. As a resolvent and stimulant in tumors and ulcers it has equally as much reputation.

The emplastrum plumbi is a cooling and sedative dressing well adapted to the protection of excoriated surfaces and small wounds from the contact of the air, but it should be remembered that its continuous use may produce lead colic. To obviate all danger from this source, it has been suggested to supply the place of the oxide of lead by the oxide of zinc, which, it is stated, has the further advantage of exercising a salutary local influence upon diseased surfaces by diminishing the suppuration and facilitating cicatrization.

A preparation composed of lead plaster and soap spread upon leather or sheep-skin is an admirable application to bed-sores, and for protecting the various bony prominences of the limbs from the pressure of splints.

We have already spoken of the emplastrum resinæ, or adhesive plaster; and, therefore, have nothing further to say upon the subject under this head.

The following are formulas for extemporaneous plasters:—

℞.—Saponis ʒij;
Emplastri plumbi ʒss;
Ammon. mur. ʒj.

Melt the soap and lead plaster together, and when nearly cold, add sal ammoniac in fine powder.

This plaster stimulates the skin, excites the action of the absorbents, and disperses many chronic swellings and indurations. (S. Cooper.)

℞.—Gummi ammon. ℥iij;
Extracti conii ʒij;
Liq. plumb. acet. f℥j.

Dissolve the ammoniac in a little vinegar of squills, then add the other ingredients, and boil them all slowly to the consistence of a plaster.

Discutient. (S. Cooper.)

℞.—Ceræ flav. ʒxiij;
Terebinthinæ ʒiij;
Cupri subacetatis ℈ij.

Melt the yellow wax and turpentine together, and then add the salt of copper in a fine state of subdivision.

Used to remove corns. (Kennedy.)

℞.—Extracti belladonnæ ʒx;
Resinæ elemi ʒijss;
Ceræ alb. ʒjss.

Melt the resin and wax together, and add the extract.

A good application in painful tumors.

Instead of the belladonna, the extract of hyoscyamus, stramonium, or conium may be used; the former of which with the addition of

fifteen grains of gum opium, was employed by Hufeland, applied to the temples, to combat insomnia. Ricord employed opium and conium in syphilitic pains of the bones and joints.

℞.—Emplastri conii ʒijss ;
Picis Burgund. ʒiss ;
Emplastri plumbi ʒiss. Misce.

Spread upon a piece of leather the size of a dollar piece, and sprinkle over its surface ten grains of tartar emetic.

Used to stimulate indolent buboes. (Corsin.)

LINIMENTS "are preparations intended for external use, of such consistence as to render them conveniently applicable to the skin by gentle friction with the hand. They are usually thicker than water, but thinner than ointments, and are always liquid at the temperature of the body." (*U. S. D.*)

They are commonly applied by means of friction with the hand or a piece of flannel, though it is sometimes preferable to smear them upon cotton or linen, and lay this upon the diseased or injured parts.

Liniments are generally stimulating and counter-irritant, yet we possess in the linimentum simplex of the Pharmacopœia an agreeable emollient application in roughened and chapped conditions of the skin, and in the linimentum opii an anodyne useful in sprains and bruises and in rheumatic and gouty pains; for the same diseases, the common domestic remedy is the ordinary hartshorn liniment.

In recent burns and scalds an elegant and efficient dressing will be found in the linimentum calcis, smeared over raw cotton and then applied to the surface; this is also called Carron oil, from having been used extensively at the Carron iron works in Scotland.

The camphorated soap liniment, or opodeldoc, is an excellent article for cleansing and hardening parts subject to pressure, and is exceedingly refreshing to the feelings of patients confined upon their backs with fractured lower limbs. In these cases the liniment may be rubbed upon the skin of the posterior surface of the body with a fine sponge, and then wiped off with a soft towel.

The compound ammoniacal liniment is directed, in the Pharmacopœia, to be prepared of two strengths, the first containing $\frac{5}{8}$ of its bulk of strong liquor of ammonia, and the second of only $\frac{5}{10}$; they are imitations of Granville's counter-irritant lotion, and are equally efficient.

The stronger preparation is used where a speedy counter-irritant effect is desired; it will produce rubefaction in from two to eight minutes, and vesication in from three to ten, and a caustic effect in a somewhat longer period. A convenient method of applying and limiting its action is to saturate a piece of lint with the strong solution, then place the lint in the lid of a pill-box, and lay this on the spot we desire to vesicate.

Other forms of liniments are also occasionally used: the linimentum æruginis, for repressing exuberant granulations and to stimulate flabby and ill-conditioned ulcers; the camphor, cantharidal, and turpentine liniments, to relieve rheumatic and neuralgic pains. Dr. Kentish originally proposed the turpentine liniment as a remedy in burns and scalds. It should be applied as soon after the occurrence of the accident as

possible, and should be discontinued when the peculiar inflammation excited by the fire is removed. It may be used in the same manner as the Carron oil.

Formulæ for extemporaneous liniments:—

℞.—Camphoræ ℥iss ;
Chloroformi f℥ij ;
Olei olivæ f℥ij. Misce.

Used in neuralgic pains. (Price.)

℞.—Olei olivæ f℥ij ;
Balsam. Peru ʒj ;
Spermaceti ʒij ;
Ceræ alb. ʒij ;
Acidi hydrochlo. fʒij ;
Aquæ fʒvj. Misce.

An excellent stimulant in chilblains. (Hospital of Saint Antoine.)

℞.—Ammonia carb. ʒij ;
Alcohol f℥ij ;
Aquæ f℥x.

Dissolve the carbonate of ammonia in water, and add the alcohol.

Useful in ecchymosis and contusions. (Swediaur.)

℞.—Ol. tiglii fʒss ;
Ol. cinnamomi fʒj ;
Ol. olivæ fʒj ;
Lin. cantharid. f℥j. M. ft. liniment.

For neuralgia. (Prof. Jackson.)

℞.—Tinct. opii fʒij ;
Saponis ℥ss ;
Ol. olivæ ℥iv. Misce.

This is employed at the Hôtel Dieu for its anodyne effects.

℞.—Ol. terebinth.,
Ol. lini, āā Oss ;
Ol. succini,
Ol. juniperi, āā f℥iv ;
Petrol. Barbadensis ℥iij ;
Petrol. American. ℥j. Misce. "The British Oil."

Used as a stimulating liniment.

℞.—Carbonis sulphu. fʒj ;
Camphoræ ʒij ;
Spts. vin. gal. f℥ij ;
Ol. olivæ f℥iij. Misce.

Used in chronic articular diseases. (Wutzer.)

℞.—Extracti belladonnæ gr. xv ;
Tinct. opii ʒj ;
Ol. olivæ ℥j. Misce.

To be gently rubbed upon the temples for insomnia. (Simon.)

Glycerine.—When pure, glycerine is a thick, syrupy fluid, unctuous to the touch, without odor, colorless, or with a slight tinge of yellow, and having a very sweet taste. It is soluble in water and alcohol in all proportions, but insoluble in ether; is insusceptible of rancidity, and does not undergo spontaneous change of composition

by keeping or exposure. Scheele discovered it in 1789, and Mr. T. De la Rue, of London, first employed it surgically in 1846.

It is produced extensively as a collateral educt in the manufacture of candles. According to the formula of the U. S. Pharmacopœia, it is obtained for pharmaceutical use in the process for making lead plaster; though the purest article is now prepared by subjecting fatty bodies to the action of water, at a high temperature under pressure.

Its properties will vary according to the process employed in its manufacture; when free from all impurities it is a very bland and soothing application; while on the other hand, the presence of lime, chloride of calcium, sulphuric or hydrochloric acids, the most common foreign matters present in it, will confer a more or less irritating quality.

Glycerine has been used internally as an alterative and nutrient in those cases in which cod-liver oil is administered.

As a dressing for wounds and ulcers, it possesses all the advantages of simple cerate, protecting their surfaces, and preventing the pieces of the dressing adhering to them, with the additional recommendation of keeping them clean and moist. We speak now of pure glycerine, for the admixture of the impurities above mentioned will render it unfit for direct application to recent solutions of continuity.

The granulations, under the dressing, become florid, firm, and healthy, suppuration gradually diminishes, and cicatrization is promoted.

The glycerine can be conveniently applied as follows: Moisten a perforated compress with it, which is to be placed upon the wound; over this lay a gateau of charpie dampened with water; then secure the whole with a few turns of a roller. The next day the dressing may be removed with ease, and the part cleansed, if necessary, with water and sponge.

M. Maisonneuve employs, as a dressing for wounds, compresses saturated with glycerine either pure or holding in solution one-thousandth part by weight of carbolic acid. He believes the glycerolate of phenole formed in the above mixture a better disinfectant than the permanganate of potassa.

Mixed with the materials of a poultice, in the proportion of from one to three drachms or more, it keeps the dressing moist and soft a long time.

As an excipient it is also a useful article, freely dissolving iodine, iodide of potassium, morphia, strychnia, veratria, atropia, and tannin.

Glycerine is used to relieve the dryness, occasioned by inflammation of the lining membranes of the eyelids and external auditory canal, and to soften concreted cerumen; as an emollient in pityriasis, lepra, herpes, and other skin diseases; and, combined with borax, as an application to inflamed and ulcerated conditions of the throat and pharynx.

The following recipes show the manner in which it may be combined with other drugs.

℞.—Gummi tragacanth. gr. xv;
Aquæ calcis f℥iv;
Glycerinæ pur. f℥vij;
Aqua rosæ f℥iij. Misce.

Used in superficial burns, excoriations, impetigo, and chapped lips. (Stratin.)

℞.—Acidi nit. dil. f℥ss;
Bismuth. subnitratis ʒss;
Tinct. digitalis fʒss;
Glycerinæ pur. fʒvij;
Aquæ rosæ f℥iv. M.

Used as a lotion in prurigo, lichen, lepra, and itching of the skin.

℞.—Sodæ biboratis ʒss–ʒj;
Glycerinæ fʒvij;
Aquæ rosarum f℥iv. Misce.

Used for sore nipples, chapped lips, irritation of the skin from shaving, sunburn, and pityriasis.

℞.—Linimenti saponis camph. f℥ij;
Glycerinæ fʒvij;
Extracti belladonnæ ʒj. Misce.

A good application for sprains, contusions, and gouty, rheumatic, and neuralgic pains. (Bouchardat.)

Lotions.—These are variously medicated fluids applied warm or cold to diseased parts according to the necessities of each individual case; they are always extemporaneous preparations, and hence are exceedingly numerous. Their therapeutical effects are usually astringent, stimulant, narcotic, or refrigerant; and the formulæ below are examples of these different classes.

Astringent lotions:—

℞.—Tannin ℈j;
Spts. vini rect. f℥ss;
Mist. camph. f℥vj. Misce.

Used for spongy gums.

℞.—Aluminis ʒij;
Aquæ rosarum f℥viij. Misce.

An injection in gonorrhœa, conjunctivitis, &c.

℞.—Gallarum cont. ʒij;
Aquæ pur. f℥viij.

Macerate five hours, and strain.

The liquid may be employed in relaxed conditions of the mucous membranes of the throat, vagina, and rectum.

℞.—Zinci sulph. ʒj;
Aquæ pur. f℥viij. Misce. "The White Wash."

Employed as an astringent in various forms of inflammation.

℞.—Liquor plumbi subacetat.,
Spts. vini, āā fʒj;
Aqua rosarum Oj. Misce.

Used in chronic inflammations.

℞.—Cupri sulphat. ℈ij;
Pulv. cinchonæ ℥ss;
Aquæ fluvialis f℥viij. Misce.

Used in syphilitic ulcerations of the throat. (Physick.)

℞.—Ferri et potass. tart. ʒj;
Aquæ ℥j. Misce.

An excellent lotion for sloughing sores.

Stimulating lotions:—

℞.—Hydrarg. chlo. mitis ʒj;
Aquæ calcis f℥viij. Misce. "The Black Wash."

℞.—Hydrarg. chlo. corros. gr. ij;
Aquæ calcis f℥viij. Misce. "The Yellow Wash."

Both of these lotions are much used as a dressing for chancres, applied with a pellet of lint.

℞.—Acidi chlorohydric. gtt. xv;
Lactucarii ʒss;
Aquæ puræ f℥vj. Misce.

Employed as a mouth-wash in excessive ptyalism. (Ricord.)

℞.—Ammoniæ mur. ℥ss;
Aceti,
Spts. vini, āā Oj. Misce.

As a lotion in sprains, bruises, and ecchymoses.

℞.—Ammoniæ mur. ʒj;
Spts. rosmarini Oj. Misce.

Used as a discutient, and in the first stage of "milk breast." (Justamond.)

℞.—Sodæ biboratis ʒj;
Aquæ pur. f℥iijss;
Spts. vini f℥ss. Misce.

For sore nipples. (Sir A. Cooper.)

℞.—Liquor plumb. subacet. f℥j;
Tinct. camph.,
Spts. vini, āā f℥ss. Misce.

As a discutient of tumors of the breast. (Brodie.)

Narcotic lotions:—

℞.—Pulv. opii, ext. conii, ext. belladon., vel ext. hyoscyami ℈j ad ʒij;
Aquæ ferventis f℥vj.

Macerate two hours, and strain.

Used as a dressing for painful ulcerations.

℞.—Acidi hydrocyan. fʒj;
Lactucarii ʒj;
Aquæ f℥iv. Misce.

To relieve the pain of cancerous ulceration. (Magendie.)

℞.—Plumbi acet. ʒij;
Tinct. opii f℥ss;
Aquæ Oj. Misce.

Used as a lotion to sprains, dislocations, &c.

℞.—Vini rubr. f℥ij;
Tinct. opii fʒj;
Aquæ f℥ij. Misce.

Apply to chancres with a pellet of lint. (Ricord.)

Refrigerant lotions:—

℞.—Sodii chloridi,
Potass. nitratis,
Ammoniæ mur., āā ℥j;
Aquæ Oij. Misce.

℞.—Ammoniæ mur. ʒj;
Potass. nitratis ʒij;
Aceti f℥j;
Aquæ f℥x. Misce. Schmucker's Mixture.

℞.—Ætheris sulphuric.,
Alcohol,
Liquor plumbi, āā f℥j. Misce. (Sargent.)

Collyria.—In its most extended meaning, a collyrium signifies any remedy applied to the eye, whatever may be its physical condition, though the term is now generally used as a synonym of an eye-wash.

Collyria are always extemporaneous formulæ, and are generally composed of astringent, stimulating, or narcotic drugs, combined in various proportions; the mild solutions being properly eye-washes, while the more active receive the name of eye-drops.

They act either directly upon the parts to which they are applied, or by absorption. In the former case their action is generally confined to the skin and mucous membrane of the eye and its appendages, though it must be remarked that strongly irritating articles produce congestion of its deeper structures. Properly managed, they are exceedingly neat and advantageous therapeutical means; while, on the other hand, their careless or improper management may entail irreparable damage, if not total loss, of the organ of vision.

In applying an eye-wash, the liquid may be placed in a dish, and soaked up with a soft linen rag or sponge, and the eye washed with it, while the head is held over the vessel. When the secretion is very copious, a syringe charged with the fluid, and its beak gently insinuated beneath the lids, without pressing the ball of the eye, will effectually clear it away.

Eye-drops are to be instilled into the eye by means of a quill, glass-tube, or camel's hair brush. Another way is to seat the patient in a chair with his head thrown back; the diseased eye being closed, place a few drops of the solution in its inner corner; then move the lids in opposite directions a few times until the collyrium has come in contact with every part of the conjunctiva. With a little elastic bottle and tube, the quantity may be graduated to a nicety.

Eye-salves should be formed of finely-levigated powders, free from all grittiness, combined with such fatty matters as will readily melt by the heat of the eye.

The most convenient way of applying them is to take a bit of the salve the size of a pin's head upon the end of a probe, and, raising the upper lid, place it beneath, and gently rub the lid upon the globe of the eye for a moment or so, while the salve is melting, to diffuse it over the conjunctiva.

The eyelids may also be everted and the preparation applied with the point of the finger or a camel's hair brush. It is proper to remark that in all cases it will be better to remove all scales or scabs adhering to the margins of the lids by the preliminary application of glycerine.

Eye powders should be very fine and impalpable; they usually consist of some metallic oxide in combination with powdered rock-

candy as a basis. The powder may be brought into contact with the conjunctiva either by taking it up upon the point of a camel's hair brush, or by placing it in a quill, and with a gentle puff of the breath projecting it into the eye.

M. Gariel has invented an ingenious little instrument which he calls a *pyxis,* for this purpose. It consists of a hollow stem connected with a little gutta-percha bulb, which has its distal hemisphere enfolding with the proximal one in such a manner as to form a little cup-shaped cavity, into which the powder is placed. This is held opposite the eye, and the surgeon, placing the open end of the tube in his mouth, by a gentle puff forces outward the enfolded part of the bulb containing the powder, the latter impinging upon the conjunctiva. Instead of the mouth, he sometimes uses a gum-elastic ball to effect the insufflation.

These powders are objectionable on account of the pain they produce. All the good results likely to follow their application can generally be obtained by their solutions, yet in cases of obstinate ophthalmias, and corneal opacities, their use is still recommended by high authority.

Eye-vapors have almost fallen into disuse; they are stimulating, narcotic, or emollient, according to the nature of the substance from which they are obtained. The application is sufficiently simple—the patient has only to hold the diseased eye over the vessel from which the vapor issues.

When there is ulceration of the cornea, care should be taken in using collyria containing opium and the salts of lead and silver in solution; for by double decomposition of those bodies, there results a soluble salt of morphia, formed by the acid of the metal, and an insoluble meconate of the lead or silver, whichever is present, that fixes itself upon the ulcers, and forms permanent opacities.

Strong collyria of any sort, when continued for a long time, produce chemical change and discoloration of the conjunctiva.

The salts of mercury, copper, zinc, and cadmium will produce no deposition with opium. The application of eye-washes may be made by the patient or his attendants, but the other forms of collyria should be applied by the practitioner himself.

For the purpose of expanding and contracting the iris, two active articles of the materia medica are used—belladonna and the Calabar bean.

To produce an enlargement of the pupil, the belladonna in the form of an extract thinned a little with water, an ointment, or a solution, is applied to the margins of the orbit pretty freely; the result will be obtained, if the article is good, in four or five hours. To effect the same purpose more quickly and elegantly, the active principle of belladonna (atropia), dissolved in water (gr. ij–iv ad f℥j), is now more commonly employed; two or three drops of this placed in the eye will dilate the iris fully in from two to twenty minutes. Other forms, recently introduced, are atropized paper and gelatine, which are prepared by incorporating the atropia with sheets of the two abovementioned articles, and then dividing them into little square pieces,

each containing about $\frac{1}{50}$ of a grain of atropia. One of these squares is to be placed beneath the lid.

For contracting the iris the Calabar bean is used, prepared with thin paper or gelatine, like atropia.

The following are examples of some of the more common collyria:—

℞.—Belladonnæ extracti ʒss;
Aquæ puræ f℥viij.
Solve et per linteum cola.
Sedative eye-water to be used tepid. (Jones.)

℞.—Hydrarg. cyanidi gr. j;
Aquæ destillat. f℥iv. Misce.

Used in glandular blepharitis of scrofulous patients. (Desmarres.)

℞.—Extracti belladonnæ gr. xx–xxx;
Aquæ destillatæ f℥j.
Solve et per linteum cola.
To be dropped into the eye for dilating the pupil.

℞.—Atropiæ sulphat. gr. ij–iv;
Aquæ destillatæ f℥j. Ft. sol.

For the same purpose as the preceding.

℞.—Tannin gr. xx;
Aquæ pur. ℥j. Solve.
To be dropped into the eye.

℞.—Cupri sulph. gr. j;
Tinct. opii gtt. x;
Aquæ destillat. f℥ss. Solve.
Drop into the eye.

For chronic ophthalmia. (Sichel.)

℞.—Zinci sulph. gr. x;
Sodii hydrochlor. gr. x;
Aquæ rosarum f℥j. Misce.
To be dropped into the eye.

℞.—Zinci sulph.,
Sodii hydrochlor., āā ʒj;
Aquæ rosarum f℥viij. Solve.

An eye-wash. (Hartshorne.)

℞.—Lapidis divini gr. xv;
Aquæ rosarum f℥ij. Solve.
To be dropped into the eye for chronic conjunctivitis. (Bouchardat.)

The same quantity to eight ounces of rose-water will make a good eye-wash.

℞.—Argenti nitratis gr. v–x;
Aquæ puræ fʒj. Solve.
To be used as eye-drops in inflammatory conditions of the conjunctiva.

℞.—Hydrarg. bichlor. gr. j;
Ammoniæ hydrochlorat. gr. x;
Aquæ rosarum f℥viij. Solve.

An eye-wash.

R.—Cadmii sulph. gr. j;
Tinct. opii gtt. x;
Aquæ destillat. f℥ss. Solve.

Eye-drop. (Sichel.)

℞.—Præcipitati alb. gr. xv;
Tutiæ præp.,
Boli armen. ppt., āā ʒss.
Adipis suilli ʒj–ʒij.
M. exactissime, ft. unguent. ophthal.

James' ointment.

℞.—Hyd. oxidi flav. gr. x–lx.
Ung. cetacei ℥j. M.

An admirable application in conjunctivitis and phlyctenular corneitis. (Pagenstecher.)

℞.—Argenti nitratis gr. x;
Aquæ destillat. q. s. ad solvend. nitrat.;
Unguenti cetacei ℥j.
Prius solvatum nitras; dein misceatur accuratissime solutio cum unguento.

Used in chronic and acute inflammations of the conjunctiva. (Jones.)

℞.—Oxidi hydrarg. rubri bene levigat. gr. iij–vj–xv;
Axungiæ præparat. ʒij. Misce accuratissime ft. unguent. oph.

For inflammation of the eyelids, and ulcers and specks of the cornea. (Jones.)

℞.—Acidi tannic.,
Pulv. sacch. alb., āā pp. æq. Misce et tere ut ft. pulv. subt.

℞.—Plumbi acetatis gr. x;
Sacchari alb. ʒj. Misce et tere, etc.

℞.—Calomelanos,
Sacchari purif., āā pp. æq. Misce tere, etc.

℞.—Oxidi hydrarg. rubri gr. x;
Sacchari purif. ʒj. Misce et tere, etc. (Jones.)

These ophthalmic powders are to be applied to the eye in the manner above directed.

Gargles.—These are liquid medicated preparations destined to act upon the mucous membrane of the mouth and pharynx. Their action is exclusively local, as they remain so short a time in contact with the parts that no absorption can take place, and therefore no remote effects can follow.

The quantity directed for a gargle may be six or eight ounces, which will suffice to wash out the throat five or six times during the day.

In the act of gargling, almost all the muscles of the neck, larynx, and pharynx participate, and it will, therefore, be prudent to abstain from the use of these preparations in severe inflammatory conditions of the throat, as it is probable that more pain will be inflicted and more injury done in such cases than can be counterbalanced by the advantage derived from their use. Yet even in these instances the gargle may be available; by simply taking it in the mouth, and throwing the head back, the fluid will be carried by its own gravity over the diseased surface, where it may be permitted to remain a few moments.

As the act of gargling is accomplished by the voluntary and forcible emission of the breath through the liquid, the agitation of which gives rise to the peculiar sound from which the name is derived, this mode of medication is impossible in very young children.

Strong solutions and the powders of certain drugs may be conveniently applied to the throat with a camel's hair brush mounted upon a long handle, or a bent probang, or even the index finger: in this manner Bretonneau has availed himself of the action of powdered alum, calomel, and other medicaments in the treatment of croup and inflammatory affections of the throat. The therapeutical effects of gargles are generally emollient, astringent, tonic, or detersive. They are the objects of extemporaneous prescription of which the following recipes are characteristic examples:—

℞.—Acidi chlorohyd. fℨij;
Mellis f℥j;
Decoct. hordei Oj. Misce.

Used in aphthous ulcerations of the mucous membrane, gangrenose angina, and ptyalism. (Ricord.)

℞.—Ammoniæ hydrochlo. ʒj;
Mellis ℥iss;
Aceti ʒij;
Aquæ rosarum ℥xij. Misce.

A good detersive and stimulating gargle in congestive conditions of the mucous membrane.

℞.—Aluminis ʒj;
Mellis f℥j;
Aquæ rosarum f℥viij. Misce.

An astringent gargle.

℞.—Sodæ biboratis ʒij;
Syrupi gummi acac. f℥j;
Decoct. hordei Ojss. Misce.

Employed in aphtha.

℞.—Hydrarg. bichlo. gr. ij;
Mellis f℥ss;
Aquæ destillat. f℥iv. Misce.

For syphilitic ulceration of the throat.

℞.—Ol. terebinthinæ f℥ss;
Mucilag. gummi arab. f℥iv. Misce.

Used to control excessive salivation. (Geddings.)

℞.—Potass. chloratis ʒij;
Mellis f℥ss;
Aquæ puræ f℥iv. Misce.

For the same purpose as the above.

℞.—Acidi sulphurici gtt. xx;
Mellis ℥j;
Decoct. hordei f℥iv. Misce.

A detersive gargle in gangrenous inflammations of the throat.

℞.—Sinapis alb. ℥ss;
Sodii chlo. ʒiss;
Aceti f℥ss;
Aquæ ferventis f℥viij. Misce.

Used in inflammatory affections of the throat. (Fleury.)

Collutories are certain forms of remedial agents intended for application to the mucous membrane of the mouth. Powdered alum, calomel, and borax are occasionally applied with a camel's hair brush to the ulcerations occurring in the same parts.

The following are illustrative forms in which collutories are ordered:—

℞.—Cincho. rubr. pulv.,
Carbo. ligni pulv.,
Irid. flor. pulv., āā ℥ij. Misce. (Dunglison.)

℞.—Tinct. myrrh. f℥ss;
Tinct. cincho. f℥j. Misce.

These formulæ are used in cases of sponginess or excrescences of the gums.

℞.—Calcis chlorinat. gr. xx;
Mucilag. acaciæ f℥j;
Syrupi f℥ss. Misce.

For mercurial sore mouth.

℞.—Sodæ biboratis ℥j;
Mellis f℥j. Misce.

Used for aphthous ulcerations.

POULTICES, or CATAPLASMS, are soft, moist, and pap-like substances, for spreading upon muslin, and intended for external application.

When they act by virtue of their warmth and moisture only, they are called simple poultices, while the addition of any drug confers the name of medicated or compound poultices upon them.

Their base, or *excipient* as it is called, is usually some farinaceous substance, such as linseed meal, rice, barley, or wheat flour, crumb of bread, sometimes the roots, bulbs, and leaves of certain plants, such as the potato, the carrot, onion, marshmallow, and benne.

The *vehicle* of a simple poultice may be water or any other bland fluid, and this charged with active principles before being mixed with the excipient furnishes cataplasms with qualities as varied as the principles themselves.

Various animal matters have been employed in this manner, and it need scarcely be remarked that they are as inefficient as they are disgusting. In this category fall those poultices made of the common earth-worms, snails, and the various parts of freshly-killed animals. A chicken or other fowl split in halves, that the warm, steaming flesh and blood may come in contact with the diseased parts, is sometimes used as a popular remedy for the poisonous bites of certain animals, as snakes and mad dogs.

In the preparation of a poultice we cannot do better than follow the advice of Mr. Abernethy, who studied with great care and enthusiasm this form of surgical dressing. For making a bread poultice he says: "Put half a pint of hot water into a pint basin; add to this as much of the crumb of bread as the water will cover; then place a plate over the basin, and let it remain about ten minutes; stir the bread about in the water, or, if necessary, chop it a little with the edge of the knife, and drain off the water by holding the knife on the top of the basin, but do not press the bread, as is usually done; then take it out lightly, and spread it about one-third of an inch thick on some soft linen and lay it upon the part." "When thus made," he rapturously exclaims, "Oh! it is beautifully smooth; it is delightfully soft; it is warm and comfortable to the feelings of the patient."

For a linseed-meal poultice he directs you to "scald your basin by

pouring a little hot water into it, then put a small quantity of finely-ground linseed meal into the basin, pour a little hot water on it, and stir it round briskly until you have well incorporated them; add a little more meal and a little more water, then stir it again. Do not let any lumps remain in the basin, but stir the poultice well, and do not be sparing of your trouble. If properly made, it is so well worked together that you might throw it up to the ceiling, and it would come down again without falling to pieces; it is, in fact, like a pancake. What you do next, is to take as much of it out of the basin as you may require, lay it on a piece of soft linen, let it be about a quarter of an inch thick, and so wide that it may cover the whole of the inflamed part."

If any of the constituents of poultices are volatile, the degree of heat to which they are exposed in preparation should be carefully watched, that their chemical integrity may not suffer change.

A temperature between 80° and 90° Fahr. will be both safe and appropriate for an emollient poultice; at a few degrees above this excitant and even rubefacient effects follow.

It will add much to their elegance and efficiency first to make a solution in water of any remedial agent we may desire to use, and then incorporate it with the other materials; thus, instead of employing bruised, or chopped vegetable matters, we use their decoctions or infusions where it is practicable.

Cataplasms may be applied directly to the skin, or have interposed a piece of gauze, tulle, or fine open textured muslin. The first plan is generally preferable, as the pasty consistence of the poultice permits an accurate contact with the whole extent of any surface however irregular, and it ought to be especially adopted when there is present any principle intended for absorption. The interposition of a piece of cloth has the supposed advantage of preventing any part of the poultice sticking to the skin, or flowing beyond the limits intended and soiling the clothes of the patient's bed. But when the cataplasm is properly made, these objections do not exist, and, therefore, the interposed muslin is useless, except, perhaps, when the applications are destined for the eye, ear, and nostrils.

It should also be observed that an uncovered poultice is more agreeable to the feelings of a patient than one provided with a covering of tulle or other material. The warmth and moisture of a poultice may be, to some extent, sustained by covering it with a sheet of oil silk, or India-rubber.

To retain the dressing in its proper position, we use the many-tailed (Fig. 58), or roller bandage, or that of Scultetus. In the former case the limb covered with the poultice is placed upon the centre of the bandage spread out upon the bed, or a pillow; then commencing below, the strips are crossed from side to side alternately. Each of them ought to overlap a third or half its predecessor, and be sufficiently long to encircle the limb once and a half.

When a strip becomes soiled it may be removed and another substituted for it without disturbing the rest of the bandage.

A small cataplasm may be conveniently retained, by crossing over

it narrow strips of adhesive plaster, sufficiently long to extend two or three inches beyond its margins.

Fig. 58.

Application of the many-tailed bandage for retaining cataplasms.

The removal of a poultice is neatly accomplished by seizing it by one of its margins and gradually reflecting it upon itself until it is entirely detached from the skin. Any of the paste adhering to the surface may be dislodged by allowing warm water to trickle upon it, and then be scraped off with the spatula. Should it be too hard to be removed in this way, the application for a few minutes of a compress wrung out of warm water will soften it sufficiently to admit its separation.

Before renewing the poultice, the surface should be carefully cleansed and wiped with a soft towel.

Cataplasms by their warmth and humidity maintain a constant warm bath around the parts with which they are in contact; they soften the skin and facilitate the absorption of any medicament which may be incorporated with them. In order to obtain uniform effects, an unvarying temperature must be kept up by changing the poultice every two or three hours, or even more frequently if necessary. Left on too long, its moisture escapes, leaving behind a dry, hard, and irritating mass, the albuminoid constituents of which undergoing chemical changes produce a dough at once uncongenial to the feelings of the patient and hurtful to the surface beneath. Medicated poultices should be changed yet more frequently than the simple, particularly where they contain elements alterable by heat.

The long-continued use of cataplasms augments the sensibility of the tissues, rendering them tender, causes debility, and in the case of granulating wounds or suppurating buboes, they may induce such a degree of atonicity as to arrest, or materially interfere with the recuperative efforts of nature; erysipelas and even gangrene have sometimes been seen to follow the same practice.

A vesicular or pustular eruption, accompanied with excessive itching, has been noted as an occasional occurrence, and demands the substitution of warm water-dressings for the poultice. A grayish colored puffiness also not unfrequently follows their persevering use upon suppurating surfaces.

In some diseases of the skin, and in superficial erysipelas, warm poultices are sometimes exceedingly painful: in such cases water-dressings will answer better; and, indeed, as a general rule they should always be chosen when a temperature below that of the skin is desired to be maintained in a part.

1st. Emollient poultices. We have already adverted to the direc-

tions given by that astute surgeon, Mr. Abernethy, for preparing the common bread crumb and flaxseed meal poultices. In the same manner we may employ other materials, such as bran, corn-meal, rice, wheat or barley flour, and the pulps of apples, carrots, or onions either raw or boiled. The *vehicle* may be water, milk, or other bland fluid.

Emollient cataplasms were formerly much employed in the treatment of recent wounds; but this practice is now nearly abandoned, the more elegant water-dressing usurping their place. Often in inflamed ulcers great relief from suffering is experienced by the patient from the use of a linseed-meal poultice.

But it is in cases of inflammations of the cellular tissues, or phlegmon, that these remedies are most often had recourse to; they favor maturation, and when the pus is discharged, tend to dissipate any remaining engorgement of the tissues.

Deep-seated inflammation, as of an interior organ, may be beneficially influenced by a large warm poultice surrounding the chest or abdomen. For the same purpose a jacket, made of oil silk or India-rubber, and placed next to the skin, will also be found advantageous; it confines the insensible perspiration, and thus acts in the manner of a poultice, besides protecting the skin from sudden changes of temperature; it is also lighter than a poultice.

The caution should always be taken in the use of emollients to stop short of determining any hurtful relaxation of the skin and subjacent cellular tissue, or enfeeblement of granulating wounds, or local capillary congestion, which will retard the plastic process and subsequent cicatrization. We should, as a general rule, abstain from them as far as possible in passive dropsies, and in parts disposed to gangrene.

2d. Stimulating cataplasms are such as contain some stimulating drug in their composition. It has already been observed that the most elegant method of making these is by the addition of an infusion or decoction of the medicament to the vehicle before it is mixed with the linseed meal or bread crumb, yet an efficient and gently excitant application can be obtained by using the powdered aromatic plants, such as sage, rosemary, mint, rue, tansy, and wormwood, in the proportion of one or two ounces of the powder to the materials of an ordinary sized cataplasm. Some practitioners simply soften these herbs in warm water, and inclose them between two pieces of muslin.

Tansy and wormwood have been used as anthelmintics in the shape of poultices laid over the abdomen, and may be regarded as useful adjuvants to more active internal remedies. In cases where the latter could not be employed, these poultices would be of prime importance.

The pulp of the horseradish root and the rhizoma of the Indian turnip form pretty active stimulating poultices, and the same remark applies to several of the indigenous species of the cruciferous and ranunculous plants which can be obtained in various parts of the country, and used instead of other more expensive, or, perhaps, unattainable articles.

The resins in tincture or powder may be added to emollient poultices, but they are now chiefly employed in the form of plasters.

Chlorohydric, nitric, acetic, and oxalic acids are excellent local

stimulants, the three former in the proportion of one to two drachms mixed with the materials of a common-sized cataplasm. Velpeau has derived advantage from the use of poultices containing slices of lemon, in hospital gangrene.

Mustard cataplasms will be considered in the section on rubefacients.

Alcohol, solutions of chlorinated soda, and the ammoniacal salts, aromatic tinctures, and that of camphor will form useful stimulating applications added to a poultice in quantities varying from one to four drachms.

A poultice made with yeast, sour beer, or porter is a favorite remedy with some in the treatment of gangrene; it favors the separation of the sloughs, and is a corrective of any accompanying fetor; the latter quality depending upon the antiseptic property of the carbonic acid developed during the fermentation of the poultice.

The stimulating poultices are used to promote the absorption of the effused fluids, in contusions and sprains, to resolve chronic glandular enlargements and other tumors; to stimulate the granulations of flabby ulcers; and to arrest mortification, or when the tissues are dead or sphacelated to hasten their separation.

Those containing alcohol and the volatile oils have an excitant action, and may be advantageously employed in the treatment of the chronic inflammations affecting old worn-out persons.

3d. Astringent poultices are commonly made of powdered cinchona, tormentilla, bistort, gall-nuts, tan, or tannin. These powders may be mixed with the paste of a flaxseed, or bread-crumb poultice, or even employed alone, being previously converted into a plastic mass with water.

The astringent metallic salts, such as the sulphates of copper, zinc and iron, alum, the acetate of lead and Goulard's solution, dissolved in water, answer a better purpose than the preceding articles, in cases where very powerful astringent and resolvent effects are desired.

These poultices constringe the tissues actively, and will therefore be found useful in arresting passive hemorrhages and in giving tone to relaxed parts, and in phagedenic ulceration, and sloughing buboes.

I have found a light poultice containing the sulphate of iron an admirable remedy in certain cases of erysipelas.

It has been recommended to apply a poultice containing cinchona, or a solution of quinine, to the abdomen of children suffering with intermittent fevers, where these remedies cannot be borne by the stomach.

4th. Narcotic cataplasms are obtained by mixing with the *excipient* a decoction of poppies, the watery extract of opium, or the extracts of conium and belladonna. The late Dr. V. Mott recommended highly a poultice prepared by incorporating the fresh leaves of the stramonium plant with linseed meal, or bread previously softened in water. The leaves themselves sufficiently moistened may also be used. Velpeau, in retention of urine, sometimes had recourse to a poultice of pellitory applied over the hypogastrium. Mr. North applied moistened tobacco leaves to certain cases of local inflammation attended with spasms.

Besides the above uses, narcotic poultices are employed in contusions, sprains, and in rheumatic and neuralgic pains, and colics.

Mr. Markwick, of London, brought forward as a substitute for emollient poultices and fomentations a soft porous material called spongio-piline, prepared by felting together sponge and wool, and afterwards rendering one side of the sheet impervious by coating it with a layer of India rubber. It is an exceedingly elegant article, but too expensive for general use, as separate pieces would be needed for each particular case. The fact should also be stated that spongio-piline is not near so agreeable to the feelings of a patient as a well-made poultice. The same piece can be used many times to an unbroken surface without any danger; but in suppurating wounds, it absorbs the pus, from which it is very difficult to cleanse it. The best manner of doing so is to wash the spongio-piline carefully in warm water, and then in a solution of the chlorinated soda; lastly, dry it, and pass a moderately hot flat-iron over its surface, taking care not to injure the texture of the material by the heat. Its mode of application is simple, a piece little larger than the surface to be covered is cut from the sheet, dipped in warm water, and applied with its unglazed side to the skin.

The following formulæ will show the method of preparing the different kinds of poultices:—

℞.—Pulv. lini ℥vj;
Aquæ ferventis ℔iss. Misce.

The best emollient poultice. Any other farinaceous substance can be used instead of the linseed meal.

℞.—Rad. carotæ recentis ℔j.
Bruise in a mortar, or, better, grate it to a pulp, and spread on muslin.

"Carrot poultice is employed as an application to ulcerated cancers, scrofulous sores of an irritable character, and various inveterate malignant ulcers." (S. Cooper.)

℞.—Farinæ ℔j;
Cerevisiæ fermenti,
Aquæ, āā f℥v.
Mix the yeast with the water, and add the flour, stirring so as to make a cataplasm. (*U. S. Dispensatory.*)

℞.—Pulv. carbonis ʒiij;
Micæ panis ℥ij;
Pulv. lini ʒx;
Aquæ bullientis f℥x.
"Macerate the bread with the water for a little while near the fire; then mix, and gradually add the flaxseed, stirring so as to make a soft cataplasm. With this mix two drachms of the charcoal, and sprinkle the rest upon the surface." (*Pharm. Lond.*)

This is an excellent application to fetid and gangrenous ulcers, and should be frequently renewed.

℞.—Liquor sodæ chlorinat. f℥ij;
Pulv. lini ℥iv;
Aquæ bullientis f℥vj.
"Add the flaxseed gradually to the water, constantly stirring; then mix in the chlorinated soda." (*Pharm. Lond.*)

Used to diminish scrofulous tumors and glands, and as a stimulating and antiseptic application to sloughing and other fetid ulcers.

R.—Aceti f℥j ;
Cataplasmatis lini ℔j. Misce.

Used in bruises and sprains. The mineral acids in the proportion of from one to two drachms may be added to a similar quantity of a flaxseed poultice.

R.—Cataplasmatis aluminis q. s.

"This is made by stirring the whites of two eggs with a bit of alum, till they are coagulated. In cases of chronic and purulent ophthalmia, it has been applied to the eye, between two bits of rag; and it has been praised as a good application to chilblains which are not broken." (S. Cooper.)

R.—Ammoniæ hydrochlor. ʒss ;
Liquor plumbi, subacetatis f℥j ;
Cataplasmat. lini ℥iv. Misce. (Ratier.)

Employed as an application to local inflammations.

R.—Extracti conii ℥j ;
Pulv. lini ℥ivss ;
Aquæ bullientis f℥x.

"To the water gradually add the flaxseed, constantly stirring, so as to make a cataplasm. Upon this spread the extract previously softened with water." (*Pharm. Lond.*)

Used in scrofulous, cancerous, syphilitic, and other painful ulcers.

R.—Extracti opii aquosi fʒj–fʒij ;
Cataplasmat. lini ℔j. Misce.

A narcotic poultice may also be obtained by simply sprinkling the surface of an ordinary poultice with the tincture of opium.

CHAPTER IV.

ON THE USE OF WATER IN SURGICAL DISEASES AND INJURIES.

THE employment of water in surgical practice is an important subject, and demands a careful study both as regards its local as well as its general effects.

Judiciously managed, the surgeon possesses in water an efficient remedy for the relief and cure of a very large class of diseases that habitually come within the sphere of his observation. It is at once simple and effective, always at hand, and, not an unimportant consideration, it costs nothing; so that the indigent, and those cut off by accident or necessity from communities where all the conveniences for the care of the wounded and sick are present, have in water a precious remedial agent, and one far better, in a majority of cases, than the most elaborate surgical dressings.

Bathing was had recourse to by the ancient Greeks and Romans both as a cure for disease and as a luxury; and the extent to which they indulged in it is shown by the ruins of those magnificent structures designed by them for this purpose—one of them being described as containing six thousand separate baths. It is now used over the known world for this twofold object.

We propose, however, in this place to consider more particularly the use of water as a surgical dressing, and afterwards to devote a few pages to the consideration of the manner of employing it in bathing.

SECTION I.

WATER AS A SURGICAL DRESSING.

Water-dressings are either cold, warm, or medicated; and are adapted under various conditions of temperature and medicinal impregnation to the treatment of numerous surgical injuries.

This method, as a uniform practice, is almost peculiar to modern surgery, our predecessors delighting in the profuse application of salves, plasters, and healing balms, and swathing sore and wounded parts in bundles of bandages, and various other dressings, to the certain detriment of their patients.

It should be observed, however, that Hippocrates and some of his successors did employ both hot and cold water in their practice, but unfortunately their example was not generally followed by surgeons, and it was not, indeed, before the sixteenth century that attention was again drawn to the subject.

In 1553 the quack Doublet, during the siege of Metz, performed wonderful cures with clear water from the fountains and wells, and the celebrated Paré imitated his example.

Still later, Percy, Larrey, Breschet, Bérard, and Velpeau, both wrote of and demonstrated by their practice the superiority of water over the old vulnerary applications. The latter surgeon states that he used it extensively with signal success in the treatment of certain fractures, phlegmonous erysipelas, burns, and in various wounds from contusing and cutting instruments; after operations upon the eye, in amputation, and a great number of other operations. He remarks, in regard to its advantages and disadvantages: "If it is true that cold water-dressings employed in this manner during the hot season are excellent topical applications, it is also equally true that in cold weather it is much better to have recourse to tepid water; so also is it true that the water, whether cold or tepid, almost always wets some region that we would have wished to protect; that it exposes to chills, colds, rheumatisms, inflammations of the chest, and a great number of affections often more serious than the disease itself. It is also proper to say that applied indifferently to all kinds of wounds, it may produce as much evil on the one hand as good on the other. By retarding the circulation, it produces gangrene of the contused or divided tissues; and by deranging the phenomena of inflammation, it frequently vitiates the suppuration, and rarely admits of immediate adhesion of the lips of the wound."

In England, Liston advocated very strongly the substitution of water-dressings for poultices, believing them to possess all their advantages, with the additional recommendation of greater neatness and cleanliness, and not becoming sour or injuring the sound parts.

Macartney considers that they act differently; and says that a water-dressing, unlike a poultice, prevents or diminishes the secretion

of pus, checks the formation of exuberant granulations, and removes all pain.

Kern, of Vienna, and Esmark, of Kiel, were the supporters and champions of the practice in Germany.

American surgeons have generally adopted the use of water in the treatment of wounds, fractures, and local inflammations.

In applying water care should be taken that it does not wet the patient's clothes, or the bed; this can be easily accomplished by means of a sheet of India-rubber or oiled silk, placed beneath the part upon which the dressing is applied.

Cold Water-dressings are most frequently employed in the treatment of superficial inflammations, fractures, gunshot wounds, and inflammatory engorgements.

The action of the cold is to reduce the volume and temperature of the parts to which it is applied, to constringe the muscular fibres, both through the purely physical effect of condensation, and by vital contractility, and thereby diminishing the calibre of the blood-vessels and the volume of blood circulating through them as well as its rapidity. The chemical and vital forces constantly taking place in the living tissues are also retarded.

The water should not be so cold as to produce shivering, or other disagreeable sensations, and the dressing should not consist of more than a simple fold of soft linen or lint, and it is also important to leave it exposed to the air that continual evaporation may take place, else the heat of the parts will soon raise the temperature of the cloths and thus defeat the objects in view, and instead of obtaining the therapeutical effects of cold, we shall have those of a fomentation, which are quite different.

When the linen is simply wrung out of water it will require frequent changing, in order to keep down the temperature. A piece of ice, of sufficient size to be easily borne by the part, may be placed upon the dressing, and its frequent removal will thereby be avoided. I prefer, however, an arrangement whereby a constant supply of cold

Fig. 59.

Apparatus for cold water-dressing.

water can be obtained from a cup with a few small holes perforating its bottom, and lightly closed with a few filaments of charpie so that

the fluid issues in drops. A cotton wick with one end immersed in the water in the vessel and the other resting upon the muslin to be wetted will answer the same purpose, as is seen in Fig. 59. This simple plan can be pursued anywhere, and requires little surveillance.

I have derived benefit from water-strapping in ulcers and certain forms of inveterate skin diseases, such as eczema of the lower extremities. Strips of muslin or linen are taken and soaked in cold water until they are thoroughly saturated, and they are then applied in the same manner as Baynton's dressing already described.

When a powerful and sudden impression of cold is sought for, as in strangulated hernia, some surgeons apply a thin slice of sponge saturated with ether.

M. Jobert, Surgeon to the Hôpital St. Louis, Professor Miller, and Mr. Earle were strongly in favor of treating burns with iced water, by covering the burnt parts with pledgets of lint dipped in that fluid, or with bladders of ice, and continued not for minutes, but for hours. Of course, in extensive burns attended with depression, this method would be inapplicable from the sedative effects of the cold applied to so large an extent of surface.

WARM WATER-DRESSINGS, or fomentations, are much more easily managed than cold; the temperature of the water should be such that the patient experiences agreeable sensations from its use. It may be applied by means of a piece of soft muslin folded, or, what is better, a piece of flannel. To prevent evaporation and consequent cooling, a piece of oiled silk large enough to more than cover the muslin may be laid over the dressing, and the whole secured, if necessary, with a few turns of a narrow roller.

When the inflammation and the discharge of pus are moderate, the linen need not be disturbed more than three or four times a day, care being always taken to have a fresh piece of cloth ready the moment the previous one is removed, that no sudden changes of temperature may happen to the part. It will also be advantageous to abandon the use of the warm water-dressings gradually.

Amussat, in order to do away, as much as possible, with these sudden alterations of temperature, and also to economize the time of the attendants, an important object in large hospitals, recommended for these purposes the following dressing: Place over the diseased surface a piece of tulle or muslin, perforated with numerous holes to permit the free escape of pus, which is to be absorbed by a layer of soft old muslin wrung out of warm water and laid over the tulle; this he calls the *absorbent*. The third layer, denominated the *humectant*, consists of a fine, thin, and porous sheet of amadou, also soaked in warm water, which it readily yields up to the muslin; and lastly, to prevent evaporation, oiled silk is laid over the whole. This dressing requires to be renewed but once every ten or twelve hours; it permits the matter to escape freely, sustains the moisture, and keeps up a uniform temperature in the parts.

Warm applications are extremely soothing in inflammatory affections, accompanied with undue sensibility, pain, or soreness; they relax the tissues and promote the secretions and excretions; and in

this respect are often efficient galactagogues. When cold water is disagreeable to the feelings of the patient in the treatment of fractures, gunshot wounds, and other injuries, warm water may often be substituted for it with advantage. This dressing has been highly lauded in burns and scalds, where it is said to exercise a beneficial influence in mitigating the consecutive inflammation, rendering the consequences less severe locally, and the recuperative process more speedy than under other modes of treatment.

Mr. Phillips has found the most intractable cases of eczema to yield to this mode of treatment in four weeks.

Medicated Water-dressings.—Warm and cold water, chiefly the former, are sometimes combined with emollient, anodyne, astringent, and deodorant substances. The emollients enhance its soothing effects and confer the additional advantage of not requiring the dressings to be changed so frequently.

The watery extract of opium, laudanum, the extract of belladonna, and other narcotics, increase the power of control of warm water over exaggerated sensibility of parts and excessive pain.

In applying warm dressings to portions of the body affected with disease or injury, and disposed to hemorrhage, or discharging pus inordinately, the addition of the sulphates of zinc and copper, and the acetate of lead to the water will be advantageous. The solutions of the permanganate of potassa and the alkaline chlorides, tar water, and creasote, may be employed in like manner for correcting the fetor of suppurating and sloughing sores and wounds.

Dry Fomentation is a name applied to the act of raising the temperature of parts of the body by the application of heated objects to them, such as billets of wood, bags of bran, chamomile, hops, &c.; bottles filled with hot water, and bricks heated and wrapped in napkins. The object in view being to stimulate the vital powers depressed by the shock of severe injury, either accidental, or the result of a surgical operation. In such cases, a blanket wrung out of hot water and wrapped around the patient's body, will also be found a useful means.

It should not be forgotten, however, that where there is insensibility of the skin, paralysis, or concussion of the nervous system, the utmost caution must be taken that the temperature of these bodies be not too high, as the patient, from defective sensation, may be unable to give the practitioner warning of the presence of a destructive heat in contact with his person, and therefore a greater or less extent of the skin may be destroyed before it is discovered.

Bottles filled with hot water should be carefully corked that no leakage occur and wet the bedclothes.

Immersion.—Another mode of availing ourselves of the beneficial action of water in the treatment of wounds is by immersion. It has advantages in certain cases, and deserves our consideration.

Percy remarks that in external diseases where the local heat is so exalted that it dries in a very few moments the thickest compress soaked in water, nothing would succeed better in restraining the violence of vital activity, and in restoring calmness and regularity to the organism, than plunging the part into a bath. Later, Langenbeck,

of Berlin, used it with the happiest results in lacerated and contused wounds, and after surgical operations performed upon various parts of the body. In ordinary cases he kept the temperature of the water at about 70° Fahr., and never exceeded 86°; where the inflammatory reaction was greater it was reduced to 50°. Baudens extolled a bath at 32°, a temperature at which he most frequently employed water.

It can readily be imagined that there will be some little difficulty in the localization of baths in the continuity of the limbs, but as immersion is especially adapted to the treatment of inflammatory diseases of the fibrous structures of the hands and feet, and of burns, a common tub will be all that is required. This should be sufficiently large to hold such a volume of water that the heat of the part immersed will not elevate its temperature for some time; perhaps three or four times a day the water will need renewal.

On the other hand, when the disease is located at some intermediate part of the extremities, we will say at the knee, for instance, a special contrivance will be required; and the one with which I have made my experiments answers very well. It consists of a wooden trough thirteen inches wide, eighteen long, and twelve deep, with a sheet of India-rubber ten inches wide tacked to each end, and having at their unattached borders, or free margins, elastic cords which closely encircle the limb, above and below, to prevent the egress of the water; a glass plate may be laid over the trough at the option of the surgeon. To supply the apparatus with water of a uniform temperature, a reservoir—a keg or bucket will do—is placed near to and above the level of the bed, and connected with one of the upper corners of the trough by an India-rubber tube; the corner diagonally opposite this is fitted with another tube to carry off the water and discharges from the wound into a basin resting upon the floor.

When the limb is placed in the trough, the latter should be arranged a little lower than the plane of the body and somewhat inclined, so that the pus will settle towards its outer and lower corner, where the aperture of egress is placed. If the stump of an amputated limb is to be immersed, but one of these India-rubber sheets is unnecessary, inasmuch as the box should then have four sides instead of three, as in the former case.

The only dressings that need be applied in the case of wounds and stumps are a few points of suture and a few turns of a roller.

In this manner may be treated the inflammations of the tendinous sheaths, and fibrous tissues of the palms of the hands and soles of the feet, contused and lacerated wounds, amputated limbs, and injuries of the joints.

My experience with immersion has been limited to the two latter class of cases, and the results have been gratifying.

Irrigations.—Irrigation is a method of applying water by permitting gentle currents to flow continuously over any portion of the body. It is of considerable antiquity, and the experience of surgeons all over the world attests to its great value as a therapeutical remedy in inflammations.

Various kinds of apparatus have from time to time been suggested

to effect irrigation, but one of the simplest, and at the same time as efficient as any other, however complicated, consists of a common tin pot or wooden bucket, with its bottom perforated with a few holes, through which pieces of common wick are thrust, so as to permit the water to run in a fine stream. The bucket should be affixed by a cord to the ceiling or to a hoop spanning the patient's bed.

The apparatus (Fig. 60) used by Velpeau at La Charité consists of a reservoir with a tube projecting downwards from its bottom, and

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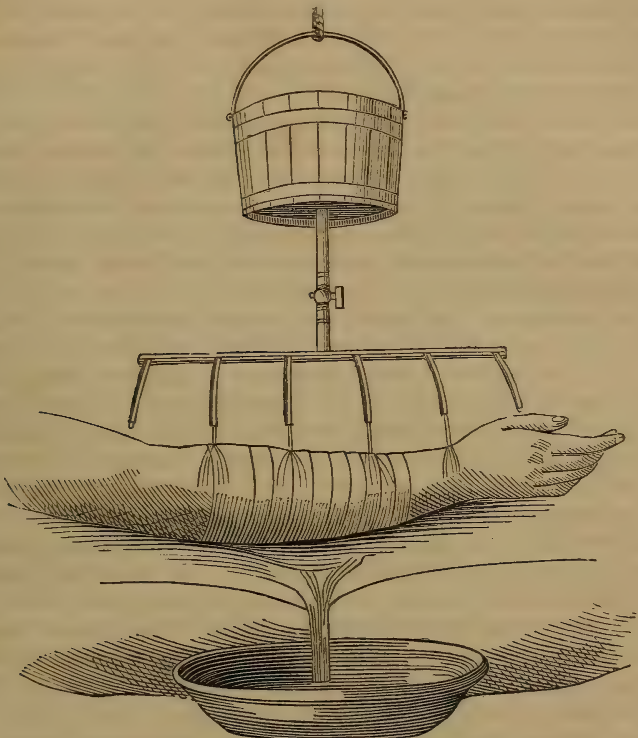


Velpeau's apparatus for irrigation.

crossed at right angles by another tube, furnished with a number of hollow stems placed at equal distances upon its length. The supply of water is regulated by a stopcock upon the vertical tube, and it flows out in a number of slender streams to fall upon the diseased part. The reservoir is suspended in the manner above mentioned.

The limb to be irrigated is placed upon a sheet of India-rubber spread out upon the bed, and so arranged that none of the water shall escape upon the bedclothes or the person of the patient, but may run directly from the limb into a vessel upon the floor near the bed.

To prevent splashing by the fall of the fluid upon the part, it may be covered with a single piece of linen.

As to the duration of the irrigation surgeons have differed in opinion; while some discontinue its use after five or six days, or as

soon as suppuration is established, others advocate its continuance for thirty and even sixty days, or until cicatrization has begun. Yet it would seem to be the best rule to abandon irrigation as soon as inflammatory action has been subdued and we have nothing further to fear from it, without regard to time or the number of days which may have elapsed.

It will be well, also, to take care that no rapid transition of temperature occurs, by simply using the cold water-dressings for two or three days after abandoning irrigation.

With a similar view the temperature of the water at the beginning of the treatment may be in the neighborhood of 76°, or about that of the healthy skin, and then gradually lowered until the desired degree of cold is obtained.

M. Malgaigne gives the preference to continued irrigation over every other method of treatment in wounds and inflammations not very deep-seated, and particularly wounds from fire-arms, and those of the hands and feet; while for other wounds he prefers intermittent irrigations.

Some discrepancies of opinion also exist as to the relative advantages of cold and warm irrigations. Nélaton would restrict the former to lacerated and contused wounds below the knee and elbow, while he allows greater latitude to warm irrigation.

Velpeau observes: "I have remarked, also, that it (cold irrigation) readily promotes a mortification of the parts when the wound was accompanied with extensive separations, or that it occupied some parts of the fingers or the hand, or the extremities in general. I have observed, in fact, that while it prevents or diminishes the redness of the skin, and the tumefaction of the deeper tissues, it often masked inflammation, rather than prevented or destroyed it; that, therefore, it does not prevent the purulent discharges, and that there finally resulted from all this a thin suppuration of a bad aspect, a general condition of things of a more serious nature, and a disposition in the wound less favorable to cicatrization than by other kinds of dressing."

Sanson states that tetanus resulted in one case of a burn treated by irrigation, and Legouest adverts to it as very often retarding or masking the appearance of inflammation, instead of preventing it; while, on the other hand, Josse and Gosselin regard it of immense service in fractures, dislocations, erysipelas, phlegmon, and all kinds of inflammations in connection with wounds.

M. Chassaignac has used irrigation of the eye for the treatment of the ophthalmia of young infants, and several inflammatory conditions of that organ, and also especially for the removal of opacities of the cornea which resist ordinary means; he reports remarkable success from the plan in these cases. The child is laid on a table, and water allowed to flow from a small vessel through a tube over the surface of the eye, during from five to fifteen minutes, several times a day.

Cold Irrigation.—The first effects of cold irrigation are to diminish the temperature of the parts to which it is applied, and to cause a painful sensation that is soon followed by one of the opposite character. Yet this is not always the case; for some patients suffer severe pain even during the whole period of irrigation. In this case its use is

clearly contra-indicated. Indeed, we have no better guide in applying cold water than the sensations of the patient.

In gunshot wounds and other injuries attended with shock to the nervous system, and depression of the vital activity of the injured parts, reaction should be first fully established before the cold water is had recourse to, as gangrene may readily be induced in them. Also when from any cause there is a tendency to gangrene, its employment is contra-indicated.

As the degree of reaction in a part is in direct proportion to the intensity of the cold, it can readily be imagined that the intermittent use of cold water may induce a series of reactions in an inflamed organ exceedingly prejudicial.

The object of cold water, as a surgical dressing, is to obtain its refrigerant effects; therefore, to avoid the shock and subsequent reaction, its temperature should be at first but a few degrees below that of the healthy skin, and its volume greater than will be necessary at a subsequent period when its temperature is lowered.

Warm Irrigations.—The method of applying warm water irrigation differs in no particular from that already described for cold water. It may be employed in those cases where the contact of cold water with the body produces painful sensations, or where, from the extent of the injury and the depressed condition of the nervous system, cold would be likely to dispose the parts, already deprived to some extent of their recuperative energy, to mortification.

Irrigation of the Nasal Fossæ.—When a foreign body gains admission into the nares, and cannot be dislodged by the ordinary means, a stream of water thrown from the direction of the pharynx will often effect it.

The sedative effects of cold water, or the emollient ones of warm water can be obtained in the same manner in inflammatory affections, ulcerations, or other morbid changes of the mucous membrane lining that cavity.

The advantage of the plan is that any liquid can be brought, continuously, in contact with the entire extent of surface of the nasal fossæ and pharynx; while by inclining the patient's head forward, no part of it flows into the gullet or trachea.

Solutions of the nitrate of silver, the bichloride of mercury, the sulphates of zinc and copper, or any other metallic salt, or astringent substances may, likewise, be successfully used in the treatment of chronic coryza and ozæna. I have lately cured a case of the latter disease of long standing, in a young man, by the injection of a strong solution of nitrate of silver.

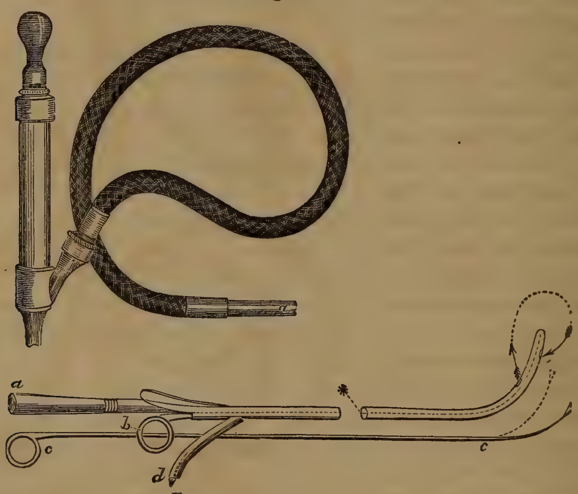
The apparatus which I have constructed for this purpose consists of a long slender tube of vulcanized rubber, bent at its distal extremity into a hook, the point of which is perforated with four holes, while the proximal end is furnished with a male screw to fasten to a syringe, or to the India-rubber ball pump, according as an intermittent or continuous action of the fluid is required. I always employ the syringe when using strong solutions of the metallic salts.

The best manner of making the injection or irrigation is to place

the patient in a chair facing the window, with his head thrown back and his mouth widely open. The operator then passes the long tube held in his right hand through the fauces, and hooks its point behind the soft palate, and after flexing the patient's head, he forces the fluid into the nares, the former running from the nose freely.

Irrigation of the Bladder.—Diseases of the bladder, such as inflammation, hemorrhage, and stone, are sometimes very much benefited by warm or cold irrigations. It can be accomplished by the double-tubed catheter seen in the figure. (Fig. 61.) The dotted line indicates

Fig. 61.



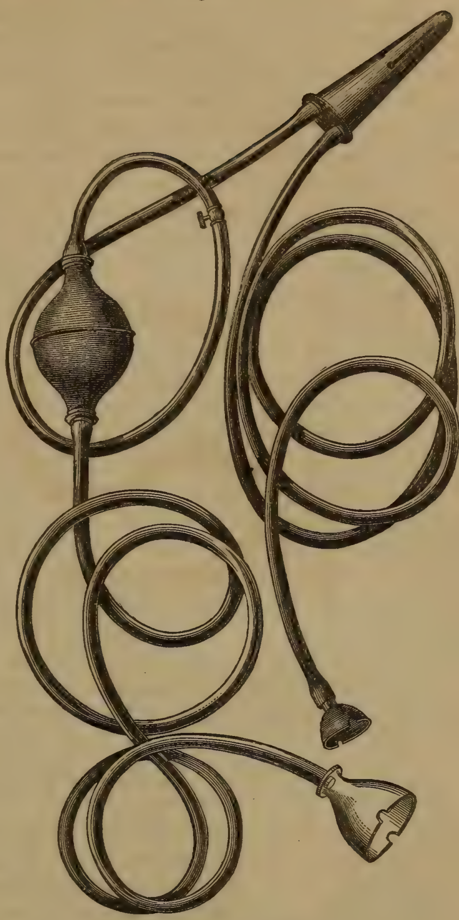
Double-tubed catheter.

the septum of division, and the arrows the course of the fluid, as it passes along the upper compartment to issue from the hole upon the concavity of the curve into the bladder, when it again enters the catheter by the hole upon the convexity to emerge through the lower division, externally. The wire stylet (*c*) is used to keep the catheter clear of clots of blood, sabulous matters, or other obstructions. The water injected may be simple, or variously medicated to answer special indications. It is forced through the instrument by a syringe, or, what is better, the India-rubber ball pump.

Irrigation of the Uterus and Vagina.—For the purpose of irrigating the vagina and uterus various contrivances have been invented, but none of them are so elegant and useful as that of Maisonneuve. It is extremely ingenious, and deserves a particular notice in this place.

As seen in Fig. 62, the vaginal portion of the apparatus consists of a hollow frustum of a cone of ebony or vulcanized rubber with vertical slits, and sufficiently large to distend the vagina moderately. Through this cone runs a metallic tube terminating at its apex in a perforated disk like the rose of a common watering pot; the proximal end of the tube projects from the base of the cone, and has attached to it a long flexible India-rubber tube with a rubber ball pump upon its middle.

Fig. 62.



Maisonneuve's irrigator.

Another tube of the same material is attached to the base of the cone, near the former, to carry off the waste water entering it through the slits.

The patient can use the instrument herself without wetting her person or the bedclothes, by simply reclining upon her back with the cone introduced into the vagina, then by pressing upon the ball grasped in the hand the water will be forced from the basin, in which the bell-shaped extremity of the tube is immersed, into the vagina. Another vessel should be placed near the bed to collect the waste water from the discharging tube.

A number of uterine and vaginal diseases may be advantageously treated in this manner, such as obstinate cases of leucorrhœa, which will often yield to the continued use of cold water. It is a good way of applying cold in uterine hemorrhage, and astringent solutions in inflammatory affections of the vaginal mucous membrane.

The Application of Water by Means of India-rubber Sacks.—There are some disadvantages attending irrigation, such as the difficulty of keeping up a uniform temperature, the wetting of the patient or the bedclothes, the disposition of the cold water to cause inflammatory affections of the chest, and lastly, in some instances, the inability of confining the water with precision to any given part by the restlessness of the patient, or from his tender age precluding the exercise of proper judgment.

Although the present method, in a measure, does away with these disadvantages, yet it is not itself free from all objections and inconvenience: of which we may instance as the principal the weight of the sacks, and the expense attending their manufacture.

I am convinced by numerous trials that there are cases in which their utility is incontestable. Two cases of perforating fracture of the skull with cerebral inflammation came under my care in which the

delirium was such that it was impossible to keep any kind of dressings upon the head without having present two or three persons to restrain the violence of the patients. Here the ice cap answered an admirable purpose, as it could be securely fastened to the head by means of the chin straps attached to it. In such cases the ice bladders will not answer any better than cold water-dressings, for their very shape, when filled with ice or cold water, will cause the edges to bulge to such an extent that it would be impossible either to cover the head entirely by them, or to retain them in place unless by the assistance of attendants. Besides, in my experience in the hospitals during the late war, bladders were not attainable while there was an abundance of oiled silk to be found, of which a very good substitute for the India-rubber cap can be made.

The heat of the scalp is such, at times, that the water in the bladders is soon rendered warm, and needs frequent renewal, in the same manner as the cold water-dressings. These disadvantages are perfectly overcome with the India-rubber cap, which covers the whole head above the face and ears, and can be so secured by the ribbons tied beneath the chin that the patient cannot displace the cap by his restlessness; it does not permit the water to run over his neck and chest, and thus produce chills, colds, and even inflammatory affections of the thorax. With a supply tube of India-rubber, and another of discharge, water of any temperature can be kept constantly passing through the cap, thus securing a never-varying temperature, a condition essential in the correct treatment of inflammation by cold.

The *Cap* (Fig. 63) is composed of double layers of India-rubber cloth formed somewhat in the shape of a helmet. With the interior of this two India-rubber tubes communicate, one for supplying the water from a vessel while the other (*c*) conveys it away from the cap to a basin. By means of the stopcock of the reservoir, the flow of the fluid is regulated, so that a constant supply of uniform temperature reaches the head. At the apex of the cap is seen an orifice (*b*) communicating with the scalp and furnishing a ready outlet for the perspiration.

Fig. 63.

India-rubber cap for applying cold water to the head.

Besides the cases I have already mentioned, in which the cap has been used advantageously, I may also mention all those diseases attended with vascular or cerebral excitement, obstinate cephalalgia, and especially that resulting from the effects of an inordinate indulgence in alcoholic stimulants. In a very few moments the sedative action of the cold water is marked, the pain disappears, and the patient, before tossing about insomnious, becomes quiet and finally falls into a gentle sleep.

The Cervical Sack.—In affections of the neck and throat we can also avail ourselves of the advantages of hot and cold water by means of the cervical sack which fits those parts and rests upon the shoulders and the upper part of the sternum.

The Spinal Sack.—This has recently been much used in obstinate cases of spinal tenderness or pain, and in diseases depending upon vascular congestion of the cord. Mr. Chapman, of London, recommends it highly in cholera. This gentleman remarks: "The bags I use are of different lengths; of the width already named" (four to four and a half inches) "for adults, and of lesser widths, of course, for children. I have had them made both of India-rubber and of linen with a surface of India-rubber upon it; the former are the best. The width of the bags is equal throughout, except at the opening, which is narrowed to facilitate tying, and elastic to admit easily the lumps of ice. When the bag is full, I divide it, if a large one, into three segments; this can be done by constricting it forcibly with a string; the ice of the upper part is thus prevented from descending, as the melting goes on, into the lower part of the bag." He bases the employment of the spinal sack upon the belief that a "controlling power over the circulation of the blood in the brain, in the spinal cord, in the ganglia of the sympathetic nervous system, and through the agency of these nervous centres, also in every other organ of the body, can be exercised by means of cold and heat applied to different parts of the back. In this manner the reflex excitability, or excito-motor power of the spinal cord, and the contractile force of the arteries in all parts of the body, can be immediately modified."

The facility of passing alternately hot and ice-cold water through these sacks will recommend them in the treatment of bed-sores after the plan of Brown-Séquard, which consists in the alternate application for ten minutes or more at a time, of iced water and hot poultices.

The *Thoracic Sack* will enable the physician to surround the chest with water of any temperature, the utility of which in inflammatory disease of the thorax, as pneumonia and bronchitis, is undoubted. We have already spoken of the advantages of the oil-silk or India-rubber jacket in this class of cases, and we have only to remark that its action is somewhat similar to that of the thoracic sack supplied with warm water, differing only in degree.

The *Abdominal Sack* is constructed upon exactly the same principles as the cap, and will be found useful in the treatment of colic, spasms of the intestines, in the passage of a gall-stone, strangury, and inflammatory affections of the abdominal organs, particularly peritonitis. M. Béhier, at the Session of the French Academy of Medicine, April 1, 1862, stated that, "since October, 1858, 801 females were confined at the Hôpital Beaujon; to 355 of these females ice was applied; 244 of the patients presented merely swelling of the annexes of the uterus, accompanied with slight pain, which soon disappeared. In 68 the symptoms were of a more menacing character, with a decided febrile reaction and a commencing alteration of the patient's features. 39 of the 801 parturients died. But even in these cases the application of the ice postponed the fatal result beyond the customary period at which it happens in cases where ice had not been applied." The ice was retained in contact with the abdomen by means of caoutchouc bags.

The thoracic and abdominal sacks may be joined, when the object is to stimulate the system powerfully, by hot water applied to a large

extent of the surface, as in the collapse from cholera, severe injury, etc. This plan is superior to that of applying hot bricks, bottles of water, etc., which, besides being troublesome, are continually undergoing variations in temperature, and come in contact with only a very limited extent of the skin.

The *Scrotal Sack* may be used in orchitis, spasmodic stricture, and retention of urine, etc.

Water Cushions, of any desired shape or size, may be constructed in the same manner, and used in the treatment of fractures of the extremities and the spine.

Sacks for the Upper and Lower Extremities.—In the few cases of chronic rheumatism in which I have tried warm water, by means of these sacks, advantage was obtained in the mitigation of the pain, and thus the patient's condition rendered more comfortable.

SECTION II.

THE USE OF WATER GENERALLY—BATHING.

We have already alluded to the antiquity of bathing, both as a sanative measure and as a luxury, and also of its universal employment at the present time for this twofold object. We propose here to consider it only in its surgical relations and uses.

Baths may be classed either according to the nature of the medium into which the body is immersed, or according to the extent to which the body is immersed into that medium. By the first method baths are arranged into the simple water, the vapor, and the dry baths.

But the second plan, which divides baths into general and local, will answer our purpose better, and we shall therefore adopt it.

General Baths.—General baths are either simple or medicated; and they vary in their therapeutical effects according to the temperature of the water employed, the manner of its application, and the nature of the medicinal impregnation.

The thermometer may be relied upon as a general guide in using baths, but the sensations of the patient will alone indicate the precise effects of bathing; for the reason that a temperature which for one person might give the sensation of cold, will in another produce one of an opposite character. Though Dr. Forbes has thought that it would be convenient to decide upon some particular temperature as the dividing line between these two classes of sensations, and he has selected that of 85° Fahr.; denominating all baths of a temperature above this warm, and all those below it cold.

Influenced also by motives of practical utility in their employment, he advises a further classification: A. Cold Baths.—1. The Cold Bath, from 33° to 60°; 2. The Cool Bath, 60° to 75°; 3. The Temperate Bath, 75° to 85°. B. Warm Baths.—1. The Tepid Bath, 85° to 92°; 2. The Warm Bath, 92° to 98°; 3. The Hot Bath, 98° to 112°.

It will be seen that in these baths we obtain a range of 79° of temperature, from 33° to 112°, which will be found amply sufficient for

all practical purposes, though occasionally a higher degree than 112° has been resorted to.

The immediate effects of an immersion in water between 32° and 35° of temperature are horripilation and numbness of the surface, convulsive anhelation, tremblings of the limbs, chattering of the teeth, and pain in the head; these effects will be more marked if the body changes its position so as to bring fresh quantities of cold water in contact with the skin. If the immersion is continued five or six minutes longer, violent pains in the stomach and acute pains along the course of the muscles will ensue; the pulse becomes quick and small, the respiration accelerated and oppressed, and the general sensibility much blunted. A longer stay yet in the water, and these symptoms will be followed by stupor and death.

If the temperature is more elevated, and the patient in vigorous health, other phenomena show themselves; the vital powers are roused into an increased activity, so that the shock is soon followed by reaction, the pulse expands, the respiration becomes freer, and the unpleasant sensations give way to others of an agreeable kind, a glow diffuses itself over the surface, and the patient feels as if possessed of renewed strength.

After a longer or shorter period, according to the degree of cold and the activity of the constitutional powers, if the bath is continued, the vital activities within cease to struggle so energetically with the physical forces, and in consequence, reaction will be succeeded by a sensation of cold, the phenomena at first described will reappear, and the system will become powerless and exhausted.

We observe clearly in all these phenomena three elements, viz., shock, refrigeration, and reaction, which it is important to separate, as each has its own individual action and influence upon disease. For instance: in torpor of the nervous system, as in syncope, we dash cold water in the face to rouse it into action by the shock impressed; here any degree of refrigeration would be pernicious, while, on the other hand, in febrile disturbance and acute inflammations we endeavor to obtain the refrigeration without the first and third elements.

We have already spoken, elsewhere, of the injurious effects resulting from the intermittent application of cold water in local inflammation, and feel convinced that often more injury than good results from its use in many cases from want of due consideration of its physiological effects.

As a therapeutical agent, cold bathing is one of the most powerful tonics in the whole range of the Materia Medica, and hence its great use in debilitated conditions of the system. In these cases, however, care should be taken that the temperature be not too low, for desirable as such a temperature may be as a corroborant, we should not, on the other hand, forget that a fatal languor may be induced.

The cool bath from 60° to 76° will answer very well as a tonic in debility as well as for persons advanced in years, and for the young who do not bear cold as well as the middle aged and vigorous. The shock is slight, and in a little while the skin glows with a delightful freshness.

Water near the temperature of the skin produces little other effect beyond the mechanical action of its weight, and may be employed for the purposes of cleanliness, and where the object is to remove adhering dust or crusts which plug up the exhalant orifices and derange the perspiratory function, and thereby cause sensations of itching, and a pimply skin.

The warm bath, 92° to 98°, produces results opposite to those of the cold bath, giving rise to pleasant sensations when the body is immersed in it, gently exciting the skin, and favoring transpiration. It soothes the nervous system, relieves pain, and at the same time excites it to healthy action; it promotes the circulation, and thereby favors an equable distribution of the blood through the whole system.

The hot bath of 100° and upwards is still more stimulating, producing increased action of the vascular system; the heart beats more rapidly, and the vessels of the head sometimes throb painfully, while the superficial vessels are gorged with blood.

Soon, however, this increased action gives way to a corresponding degree of relaxation, a profuse perspiration breaks out upon the surface which relieves the general tension of the vessels. The patient will then labor under a lassitude for some time after coming out of the bath.

When the body is sponged with water from 120° to 130° temperature, or immersed in a bath of a temperature that the patient can bear without pain, the skin becomes hot, red, and dry, and remains so for some time, little or no sedation being observed to follow. My attention was first called to this effect of hot water some years ago by a French gentleman, a traveller in India, who was in the habit of having constant recourse to it when about to begin a long and fatiguing journey under a torrid sun, and also after completing it. He assured me it gave him greater endurance and checked profuse perspiration. The remedy will be of service in those diseases attended with undue perspiratory activity, as in phthisis.

When removed from the warm bath, the patient should be carefully dried with a coarse towel, and sheltered from drafts of air and the inequalities of temperature of his chamber.

As a sedative the warm bath is used to assuage the pain from violent muscular contractions, as in colic and cramps, and to relax the muscles during the operation of the taxis, and spasmodic contraction of the neck of the bladder.

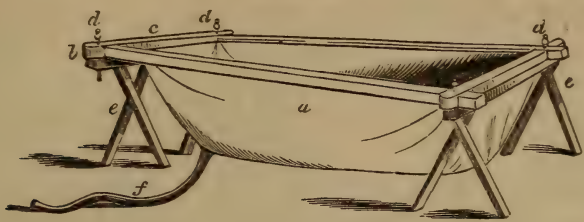
As an indirect tonic it may be employed in debility, and as a stimulant in extreme exhaustion with a concentration of the nervous energies and circulating fluids upon the interior organs. In chronic skin diseases, also, the warm bath is advantageous as a stimulant to alter its physical and vital states.

Here we can see that the stimulant effects of a warm bath may be separated, to some extent, from the sedative effects, simply by the method of its application: an important object in cases of debility in which any amount of sedation would be pernicious. To accomplish the object the bath should be of a temperature from 98° to 112°, and continued for a few moments only.

In large cities baths may be obtained at any time, and even in private dwellings the most elaborate arrangements may be found for this purpose. Where these conveniences are not attainable, the simple contrivance (Fig. 64) recommended by Dr. Thomson will answer the purpose.

He describes it as "consisting of a hammock (*a*) of Macintosh's cloth, which is extended upon two long poles (*bb*), passed through a

Fig. 64.



Thomson's bathing apparatus

broad seam on each side of the hammock, and kept asunder by the cross pieces (*cc*) which are attached to the pole by the thumb-screws (*ddd*). At one end of the hammock is an air pillow, which can be readily blown up, and below it is a flexible tube (*f*) made of the same material as the hammock, by which any water it may contain can be readily drawn off. When the poles are fixed, as in the above figure, and the open end of the flexible tube is twisted around one of the thumb-screws, the bath is ready to receive the water. It may be supported upon two chairs, or upon folding tressels (*ee*). The advantage of this bath is, that it requires a very small quantity of water compared to that demanded for other baths; that it requires no sheet for the bather to rest upon; and when the bathing is completed, the poles and the folding tressels can be placed aside in a small closet or in the corner of a dressing-room, and the hammock, when dried, put into a drawer."

For portability I have adopted a bathing-tub made of India-rubber, and having hollow walls, between which air is forced by means of a pair of bellows. After the tub has been used it should be wiped dry and the air squeezed out of its walls, when it may be folded up in a small package and kept in a drawer.

In the absence of either of these contrivances, a common washing tub or large barrel may be used instead.

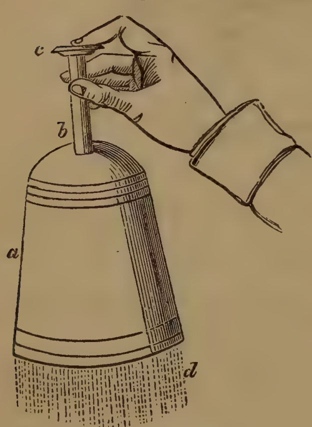
The *Shower Bath* may be either general or local, and its effect will vary with the temperature, volume, and the height from which the water falls upon the patient, but their general character will be pretty much the same as those of the plunge bath of the same temperature. It possesses the advantage, however, of enabling the practitioner to localize the action of the water in such a manner that the shock and diminished temperature may be brought to bear directly upon any given part, and thus any general perturbation of the system will be avoided, if it is so desired.

Again, some patients cannot bear the mechanical effects of the water of a plunge bath upon their bodies, as it produces a feeling of suffocation and an indescribable sense of uneasiness: here the shower bath will be found an efficient substitute.

In many dwellings shower baths are arranged in such a manner that, by means of a stopcock furnished for the purpose, the force and quantity of the falling water may be increased or diminished according to the tolerance of the patient.

A portable shower bath (Fig. 65) is now manufactured, consisting of a tin vessel of half a gallon, or a gallon capacity, with its bottom perforated with numerous holes. Its interior communicates with the air through a small tube running in the handle of the vessel, and terminates at its top by a small hole which can easily be covered with the pulp of the index finger.

Fig. 65.



Portable shower bath.

When we desire to use the vessel it should be immersed in a pail of water, and the orifice above spoken of closed with the point of the finger, which will cause the water to be retained in the vessel, after it is lifted from the pail, by atmospheric pressure.

The patient may now hold the tin over his head, and by raising the finger from the hole the water will shower upon his person.

Affusion is a rude sort of shower bath, and consists in simply dashing water from a bucket over a person, yet it produces much less shock than the former.

The vapor bath resembles, in its general effects, those of the warm bath already described, the chief points of difference being that, at corresponding degrees of temperature, the vapor bath is more sudorific and derivative, while at the same time it is much less stimulant and soothing to the nervous system, *cæteris paribus*, than the warm bath.

If the whole body is immersed in the vapor, which is breathed at the same time, its heating effects will be much increased, because the inhalation stops the cooling process taking place by evaporation from the lungs, and also furnishes just so much more space for the heating medium to act upon, as there are square inches of bronchial surface. Hence, it will be necessary, under these circumstances, to employ vapor of a lower temperature than where the exterior of the body alone is exposed.

The physical law is, that the heating power of a medium depends upon its density, conductivity, and capacity for caloric, being greater where these properties are possessed in greater degree: it follows then that the relative heating power of water and vapor will differ considerably.

The ratio of difference is expressed in the following comparative view drawn up by Dr. Forbes:—

Water.		Vapor.	
		Not breathed.	Breathed.
Tepid bath	85°—92°	96°—106°	90°—100°
Warm bath	92°—98°	106°—120°	100°—110°
Hot bath	98°—106°	120°—160°	110°—130°

The cases in which the vapor bath is employed are marked by the retrocession of the fluids upon the central organs, as in the cold stage of fever and the collapse of cholera. It is also used to alter the action of the skin in cutaneous diseases, and to remove the stiffness and rigidity of the muscles and joints.

Local vapor baths have also been recommended and employed by Dr. Macartney in painful wounds, contusions, and fractures. In otitis and otalgia a stream of warm vapor may be introduced into the external meatus by means of a funnel inverted over a vessel of hot water, the small end being placed in the meatus. The vapor bath is also occasionally medicated with the volatile and odoriferous constituents of certain plants and balsams.

Blegborough recommended an air-pump vapor bath in gout, rheumatism, and paralysis.

There are elaborate apparatus sometimes prepared for the administration of the vapor bath, but generally an extemporized apparatus that can be gotten up in any household will serve pretty nearly as well.

If the patient can sit up, place him upon a stool under which a basin of hot water is introduced, and surround him with a thick blanket, or a sheet of India-rubber cloth, in such a manner that it may hang down, all around, upon the floor: if he is not to breathe the vapor, it should be fastened above, around his neck. In the contrary case, the head may be inclosed and the blanket supported above it by a common keg-hoop firmly tied to the top of a stick, bound below to one of the legs of the stool.

Everything being now ready, a hot brick is placed in the basin, from the water contained in which steam will rise in abundance and fill the space between the patient's body and the blanket.

Another plan quite as simple is to reverse over a patient, seated upon a stool, a common wicker basket with a hole in the side for the patient to protrude his head at pleasure. The basket is covered with a blanket likewise perforated, and the steam is admitted from below by means of a tube coming from the spout of a teakettle filled with water and kept boiling upon a fire near at hand.

If the patient is confined to his bed, the blanket may be supported over his person by two or three hoops nailed to a piece of stiff wood five or six feet long. The steam is obtained from a boiling kettle, as in the former case.

Dr. J. B. Nevins, of Liverpool, has suggested a very simple method

of employing a vapor bath while the patient rests in his bed: he directs that "two pieces of coarse flannel (common scouring cloths answer the purpose admirably) are to be soaked in common vinegar, about a pint being necessary for each cloth. Two common bricks are then to be heated nearly red-hot in the fire, folded up in these flannels, and placed on two plates. The patient being stripped, one plate is to be put a little distance from one knee, and the other a little distance from the opposite shoulder, and the patient is to be covered over with the bedclothes. In a few minutes he is surrounded by a most refreshing steam bath, which produces a warm, agreeable perspiration, that may be kept up for twenty minutes or longer, if the bricks retain their heat sufficiently." In this manner, he says, he has treated acute rheumatism for a number of years, with great success, always following the vapor bath with the cold douche, which is accomplished in this way: "As soon as it is decided to remove the bricks, the patient, still in bed, is to be very rapidly mopped all over with towels wrung out of cold water, then immediately wiped dry with dry towels, supplied with a warm shirt or flannel garment, and covered with a fresh, dry sheet, etc., or with blankets alone, as may be most agreeable to him."

"The cold water application immediately on the removal of the hot vapor is very important, as it prevents the continuance of an enfeebling perspiration after the hot bath."

The *Warm Air Bath* possesses some of the qualities of the vapor bath. It is more stimulating and sudorific than the latter, but much less soothing and relaxing. It may be employed in the same class of cases, and more especially in the dry scaly eruptions of the skin. The sudatorum of Dr. Gower is made with hoops, in the same manner as the apparatus for the vapor bath already described; the tube communicating with its interior has a bell-shaped opening externally, under which a spirit lamp is to be placed. He states that a temperature of 85° produces a profuse perspiration, and that above this "the effect would be rather frustrated, owing to the ardent heat which the patient feels and complains of, without obtaining the relief which sweating invariably produces."

Dry Baths consist of some solid matters into which the body is immersed. Formerly the buccaneers of the West Indies were in the habit of burying those of their comrades affected with scurvy up to their necks in the sand, the warmth of which produced copious perspiration.

A disgusting practice, still pursued by the common people in some parts of the world, is to immerse patients in the blood of recently killed animals, mud, masses of the husks of grapes, the refuse of the olive after the oil is expressed, and other like matters.

The warm skins of animals just dead, particularly that of the sheep, wrapped around the body of the patient, with the wool side outwards, have in the opinion of some produced good results; the celebrated Marshal Lannes, Duc de Montebello, being treated in this manner after a severe injury he received by a fall from his horse.

Local Baths. *The Douse or Douche Bath.*—We must place at the head of local baths the douse, which is, perhaps, more frequently employed in surgical practice than most any other form of local bathing whatever. It consists in directing a stream of water upon some part of the body, and it depends for its efficacy upon the temperature of the water and the volume and height of the stream.

Passing rapidly over the surface, the particles of the water are always cool, and thus it becomes a most powerful refrigerant, while the percussion and the weight of the water actively stimulate the capillaries.

The douse may be either cold or warm, its stimulating, refrigerant, and tonic qualities diminishing with the increase of temperature. The warm douse may be borne as high as 180° Fahr., but it is seldom employed. Its stimulating effects are direct, and not, like those of the cold douse, the result of a reaction subsequent to a primary sedation.

The douse, affording as it does a wide range of temperature from 33° to 180° Fahr., is applicable to the treatment of numerous diseases. In chronic affections of the joints it enjoys a high reputation, the diseased part being subject to the current for fifteen or twenty minutes three or four times a day.

As a tonic in general debility it is also valuable; the patient, if very weak, may begin with a more elevated temperature, and subsequently reduce it to 40° or thereabouts.

Paralysis, not depending upon acute disease of the brain, may also be benefited. Although the douse has been recommended in the acute phlegmasiæ, yet great caution should be observed in its administration, lest more injury be done than good conferred. Chronic headache, and several species of neuralgia, especially sciatica, have yielded to its influence.

Old glandular swellings, and old ulcers verging towards the class of the *opprobria medicorum,* have sometimes happily given way to its persevering use.

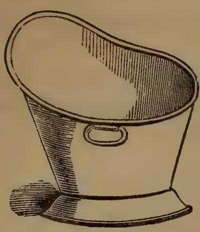
In weak eyes, and in some of their inflammatory diseases, Beer employed a special apparatus for applying the douse to the eye. It consists of a double tin vessel, the outer one for containing the ice to cool the water contained in the inner compartment; from the bottom of the latter a long tube projects, with its inferior extremity bent back upon itself, and drawn out to a small orifice from which the water falls upon the diseased eye.

Graëfe used for the same purpose a common siphon, with its short leg immersed in water contained in a vessel, while the extremity of the long limb has a gutta-percha collar fitted to it, by means of which nozzles of any calibre may be attached to the tube, to direct the stream of water in any direction.

Formerly the douse was much used in the treatment of mania, and it is stated that a column of water twelve feet high, allowed to fall vertically upon the head, produces such intensely painful sensations that the most furious maniac who has once experienced its effects will be awed by the mere threat of its application.

The *Hip-bath* (coxæluvium) is a powerful derivative remedy in diseases of the organs contained in the abdominal and pelvic cavities and the lower portion of the spine, and may be had recourse to in cases where general bathing might be contraindicated in consequence of disease of some of the great vessels or interior organs; it is also beneficial in strangury and prolapsus ani, in the latter case the addition to the water of some astringent substance would be advantageous.

Fig. 66.



Vessel for hip-bath.

The vessel used for applying the hip-bath is seen in the figure (Fig. 66).

The *Foot-bath* (pediluvium) is also used as a revulsive and counter-irritant in catarrhs and determinations of the blood to the head.

The water should be as hot as the patient can bear without pain, and made more stimulating yet, if it is desirable, by the addition of mustard, a quarter of a pound of cayenne pepper, or a handful of salt.

Twenty minutes will be a sufficiently long time for the feet and legs to be immersed in the water. The bath should be taken while the patient is in bed, with his feet hanging over its edge; or, if he is sitting up, his person should be protected by a blanket.

Other local baths have been recommended, which are only limited in number by the different parts of the body to which they can be applied. They are of real utility in many cases; for instance, in those persons who have a tendency to free and distressing perspiration from the axillæ, hands or feet, or other parts of the body, water, as hot as can be borne, will relieve the annoyance to a considerable extent.

CHAPTER V.

INJECTIONS.

Injection is the operation by which, with an instrument called a syringe, we are enabled to bring fluids of various kinds in contact with the internal walls of the different canals and cavities, whether natural or artificial, of the human body; the fluid injected also bears the same name. Injections are exceedingly numerous and varied, according to the character and locality of the cavity to be injected, as well as the nature of the fluids employed.

Simple tepid or cold water is often used to wash out pus or other secretions from the irregular passages produced by suppurative action or wounds, and where other means could not be used at all, or, at least, would be painful or pernicious to the delicate granulations.

The injected fluid is either simple water of various degrees of temperature, according to circumstances, or water medicated with emollient, narcotic, astringent, or irritative substances. We shall now consider the various kinds and methods of injection.

Injection of the Lachrymal Duct.—This injection may be accomplished from above downwards, through the puncta, or from below upwards, through the lower orifice of the nasal duct, terminating beneath the inferior turbinated bone.

The injection can be thrown through either of the puncta, though the inferior one is to be preferred. The operation is thus conducted: the patient is seated in a chair, with his head supported upon the breast of an assistant; then the surgeon, with the syringe of Anel

Fig. 67.

Anel's syringe.

(Fig. 67) held in his right hand, places its point into the orifice of the lower punctum, and holds it there a moment lightly, in order to avoid producing spasm of the canaliculus, which might occur from its too sudden introduction; he then gently passes it on to the depth of an eighth of an inch, when the contents of the syringe must be discharged without force, as the fluid ought to reach the sac with ease, if the syringe is properly introduced, and there be no obstruction in the canaliculus. While the injection is being accomplished, the eyelid should be permitted to assume its own position.

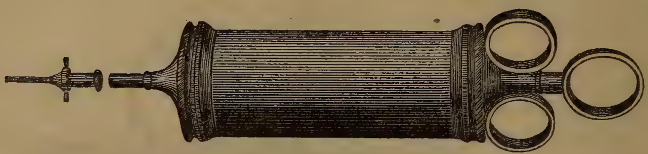
If any trouble is encountered, the introduction of one of Anel's probes will be advisable before the syringe is tried again. The injection will be required to be made through the superior punctum if the inferior is obliterated or obstructed.

The injection from below is accomplished in the following manner: The patient being placed in the same position as in the previous case, the surgeon takes one of the catheters of Gensoul in his right hand, with its convexity upwards, and its point looking downwards and outwards, and passes it into the inferior meatus to the depth of little more than an inch, when he should draw the catheter gently forwards, with its beak pressing gently upon the outer wall of the meatus, until it is arrested by catching in the inferior orifice of the nasal duct, when he suddenly depresses the outer extremity of the instrument. The syringe may then be fitted to the catheter, and the injection made. When it is necessary to wash the parts beneath the eyelids, a syringe with a little bulbous extremity may be had recourse to.

Injections of the Ear.—For the purpose of cleansing the external meatus with water, a syringe (Fig. 68) of about the capacity of four ounces is commonly used. It is provided with a smooth, slender,

cylindrical nozzle, well rounded or bulbous at its point that the delicate membrane lining that canal may not be injured; at the base of the syringe there are two rings, one upon each side, by which the instrument is held, the thumb and ring finger being passed through them. Another ring surmounts the piston rod to receive the index finger, by the aid of which the syringe is worked.

Fig. 68.



Toynbee's syringe and nozzle.

The fluid to be injected is contained in a basin held beneath the patient's ear; this also serves the purpose of catching the water as it runs away from the meatus. To insure the clothes of the patient from being wetted, it will be desirable to fasten, with a piece of wire, beneath the lobule of the ear, a tin or pasteboard gutter, which will run the water clear from the person (Fig. 69).

Fig. 69.

Toynbee's ear-spout fitted on the head.

In some inflammatory affections of the meatus the parts become exquisitely painful and sensitive, so that even with the greatest care more or less suffering will be inflicted in performing this operation, and this results in part from the size and weight of the syringe not permitting it to participate in the motions of the patient's head when he flinches from pain or is disturbed in any way. To rid myself of the inconveniences of the syringe, I have long been in the habit of using a convenient little instrument which consists of a nozzle an inch and a half long with a ring fastened to its outer extremity, and connected with the ordinary elastic-ball pump.

The mode of employing it is simply to seize the ring of the nozzle between the thumb and index finger of the left hand, and to introduce it into the meatus, while the corresponding forearm rests upon the top of the patient's head, and maintains it steady. Then with the India-rubber ball in the right hand, a stream of water may be continuously thrown into the meatus and the injection completed without removing the nozzle. This is certainly a great advantage, as it is well known that not the least painful part of this operation, as ordinarily performed, is the frequent introduction of the syringe, a measure absolutely indispensable, in a majority of cases, to obtain a sufficiency

of water to insure the thorough cleansing of the meatus or the dislodgment of a foreign body.

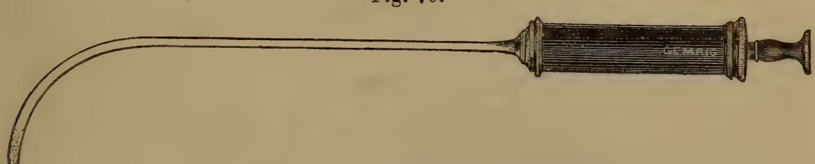
Injection of the Urethra.—Medicated solutions are introduced into the urethra by means of the little instrument called the penis-syringe; it is manufactured of glass or metal, the former being preferable, as more cleanly and free from the corroding effects of those active chemical agents which often enter into the composition of these injections. The capacity of the syringe should not be more than one ounce, as this quantity of fluid will be amply sufficient to fill the entire canal, from the meatus to the bladder.

In performing the operation the patient may either stand upright against a wall or sit upon the edge of the bed or chair, with the perineum well thrown forwards, that no pressure may be exercised upon it so as to prevent the free access of the injection to the deepest part of the urethra. The syringe, held in the right hand, may then have its nozzle introduced into the meatus, while pressure should be made upon the glans with the thumb and index finger of the left hand, to sustain it against the shoulder of the instrument, and thereby prevent the egress of any of the injected fluid.

The piston of the syringe must be pressed down slowly, as the sudden and forcible entrance of the liquid is apt to excite spasmodic action of the canal, and cause a good deal of pain. There is no danger of the injection passing into the bladder, as some patients fear, and, in their anxiety to prevent it, press upon the perineum during the operation.

Some surgeons recommend that a long curved catheter, with an olive-shaped point pierced with small holes, be used in connection with the syringe, in order to bring the solution with certainty in contact with the deeper parts of the urethra; there are diseases of its membranous portion which cannot be reached with the penis-syringe, and such an instrument as seen in Fig. 70 is required. The time that

Fig. 70.



The catheter-syringe.

the solution should be permitted to remain in the urethra will depend upon its strength; in ordinary cases three or four minutes will generally suffice. The operation may be repeated three or four times a day.

In this manner solutions of the nitrate of silver, sulphates of zinc and copper, alum, tannin, and a host of other remedies may be used in the treatment of the diseases of the urethra. The usual forms of injections will be seen from the following formulæ:—

℞.—Argent. nitratis crystal. gr. x;
Aquæ f℥j. M. ft. inject.

Used in the abortive treatment of gonorrhœa. (Acton.)

℞.—Zinci sulph.,
Acid. tannici, āā gr. ij;
Aquæ f℥ij. M. ft. inject.

Used in gleet. (Acton.)

℞.—Ferri proto-iodidi gr. ij;
Aquæ destillat. f℥viij. M. et ft. inject.

Used in gonorrhœa. (Ricord.)

℞.—Plumbi acetatis ℈ij;
Aquæ rosarum f℥v. M. ft. inject.

Used in gonorrhœa. (Ricord.)

Injection into the Bladder.—We have already considered the subject of irrigation of the bladder with the double-tubed catheter, and but few words are, therefore, necessary under this heading. For the introduction of medicated liquids into the bladder, a simple catheter is all that is necessary; this with a small syringe fitted to its orifice will enable the practitioner to bring in contact with the vesical mucous membrane any medicament he may choose.

It should be borne in mind that when this organ is inflamed and irritable the quantity of the injected fluid should be small, so as not to provoke violent contractions, and thereby cause its immediate rejection.

The diseases in which these injections have been used are cystitis and calculous affections. Dr. Hoskins, of England, employed the saccharate of lead for dissolving phosphatic calculi; Dr. Rutherford used lime-water; Dr. Ritter, caustic potassa; Sir B. Brodie, nitric acid; and other surgeons, simple water, or a solution of bicarbonate of soda. None of these trials have, however, as yet, been crowned with sufficient success to justify the retention of the plan as a surgical resource of any importance. The two following formulæ will illustrate the manner in which remedial agents are sometimes combined for these purposes:—

℞.—Argenti nitratis ʒij;
Aquæ destillat. f℥iv. M. ft. inject.

Used in cystorrhœa. (Acton.)

℞.—Sodæ bicarb. ℈iijss;
Saponis alb. ℥iss;
Aquæ destillat. f℥iv. M. ft. inject.

Used in certain calculous diseases. (Bouchardat.)

Injection of the Vagina.—Besides the plan of irrigating the vaginal mucous membrane already described, it is sometimes necessary to have recourse to another one, which consists in bringing in contact with this membrane solutions of considerable medicinal activity. The operation is performed with an instrument called the female syringe, which is cylindrical, rounded at its point and perforated with a number of small holes, and made either of glass or metal, of a capacity ordinarily of two or three ounces.

To make the injection, the patient should be placed upon her back, with the hips raised upon a pillow and the thighs elevated and drawn up; then two or three syringefuls of the fluid ought to be

thrown into the vagina to wash away any adhering mucosities or other discharges, when the third syringeful may be introduced and retained there three to five minutes, by means of a napkin pressed against the vulva.

The diseases in which these injections are employed are gonorrhœa, leucorrhœa, and various vaginal discharges.

Professor Simpson has attracted the attention of the profession to another valuable mode of applying local remedies to the vaginal mucous membrane, which consists in the combination of certain remedies with lard and wax, and giving them the form of suppositories. They bear the name of medicated pessaries. The following formulæ will indicate the manner in which these are prepared:—

℞.—Zinci oxidi gr. xv;
Ceræ albæ gr. xv;
Axungiæ ʒiss. M. f. pess.

℞.—Plumbi acetat. gr. vij;
Ceræ albæ gr. xxij;
Axungiæ ʒiss. M. f. pess.

℞.—Ung. hydrarg. fort. ʒss;
Ceræ flavæ ʒss;
Axungiæ ʒi. M. f. pess.

℞.—Plumbi iodidi gr. vj;
Ceræ flavæ ʒss;
Axungiæ gr. lxx. M. f. pess.

℞.—Tanninæ gr. x;
Ceræ albæ gr. xxv;
Axungiæ ʒiss. M. f. pess.

℞.—Extr. belladonnæ gr. x;
Ceræ flavæ gr. xxiv.
Axungiæ ʒiss. M. f. pess.

These pessaries are used in various painful and inflammatory diseases of the vagina and the adjacent organs. (Simpson.)

℞.—Zinci sulphatis,
Aluminis calc., āā ʒijss;
Aquæ destillat. Oj. M. f. inject.

Used in leucorrhœa. (Pringle.)

Injection of the Uterus.—Injections of various fluids into the uterine cavity have been performed in some cases with considerable advantage, but the operation is a delicate one, and requires circumspection, lest injury imperilling life be done to that viscus. The instrument with which it may be effected is a common syringe, holding about an ounce, and mounted with a stem about the size of a No. 6 catheter, and nine inches long.

The patient may be conveniently placed in the same position as for vaginal injection, and the practitioner having introduced his left forefinger up to the os uteri, the stem of the syringe is passed into the uterine cavity upon this as a guide.

The quantity of fluid injected at one time should never exceed an ounce, and, in order to be on the safe side, one-half or a quarter of this amount may be tried at first.

In violent uterine hemorrhage it has been recommended to inject cold water into that cavity. This can be best accomplished by a common straight catheter and the elastic ball pump.

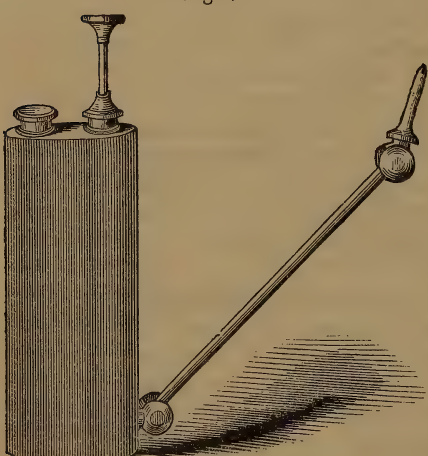
Vidal de Cassis employed in several chronic uterine diseases an injection of a decoction of the dried leaves of the black walnut.

INJECTION OF THE RECTUM, OR ENEMATA.—When injections are made in the rectum they are variously denominated glysters, clysters, enemata, or lavements.

There are numerous forms of the instrument for performing this operation: the common enema syringe, now falling into disuse since the introduction of India-rubber syringes constructed upon the principle of the force-pump, consists of a white metal cylinder, provided with nozzles of different lengths and curvatures, which may be attached or detached at pleasure, so as to enable the attendant or the patient himself to make the injection either just within the sphincter, or to a greater distance up the bowel. This syringe varies in size, holding from two to sixteen ounces or more. The inconvenience attending the use of this instrument by the patient can readily be appreciated, and the great improvement over this of the clyster pumps, of which there is an exceeding variety; but none of them are so simple in construction or effective as that manufactured of India-rubber. This consists of an oval ball of rubber with two flexible tubes attached to it, one at each of its extremities; at the base of each of these there is placed a ball valve, opening in the direction of the nozzle.

The instrument is used by introducing the pipe into the rectum, while the other end of the tube is put into a basin; and then, by alternately pressing upon and relaxing the hold on the ball, the water is sucked up and forced into the rectum.

Fig. 71.



Metallic clyster-pump.

In hot climates these tubes become soft and get out of order, so that under these circumstances a metallic instrument is to be preferred; and perhaps the best of this kind is that manufactured by Messrs. Maw and Son, of London, and seen in Fig. 71.

Dr. J. Y. Totherick has proposed an enema tube which he believes combines cheapness, simplicity, and efficiency in no ordinary degree. "The apparatus consists simply of five or six feet of three-eighths inch India-rubber tubing, to one end of which is fixed an ordinary funnel capable of holding a sufficient quantity of fluid, and to the other end one of the common ivory insertion pipes. The method of using it is as follows: first, fill the funnel with the liquid to be employed, whilst holding the exit pipe at the same level; secondly, squeeze with the finger and thumb the end of the pipe to which the ivory is attached, to prevent premature exit of the fluid; thirdly, insert the ivory exit

pipe into the rectum; fourthly, elevate the funnel to the length of the tube, and allow hydrostatic pressure to force in the injection."

Whichever kind of instrument is employed, it is important that their nozzles or pipes be smooth, cylindrical, and well rounded, or bulbous at the extremity, in order that the rectal walls be not perforated or torn, an accident which has happened, the fluid being thrown into the cavity of the peritoneum, or into the cellular tissue of the pelvis, producing in the former case a fatal peritonitis, and in the latter tedious and almost always fatal pelvic abscess.

In administering an enema, the patient may lie upon either side, with the leg which is uppermost somewhat flexed: then, if the old form of a syringe is used, having well oiled its nozzle, the surgeon gently insinuates his left forefinger, oiled, into the anus, and upon this as a director passes the point of the instrument into the rectum. The left hand should then hold the head of the syringe firmly and steadily, while the piston is being slowly forced down with the right.

In some cases the great irritability of the gut causes the sphincter to contract forcibly; but no violence should be used to overcome this, as the gradual pressure of the pulp of the finger will vanquish the resistance in a few moments.

The curved form of the rectum should always be borne in mind, that the proper direction may be given to the syringe in its introduction, which should be first upwards towards the umbilicus, then backwards and upwards, after it has penetrated to the depth of an inch, in the curve of the sacrum, inclining the nozzle a little to the left.

As to the quantity of the injection, this will depend upon the object in view. If that be simply to evacuate the intestine, the enema should be large, twelve to sixteen ounces; and to insure the fluid's remaining there a sufficiently long time to soften the fecal matters, it must be gradually forced from the syringe, to give the intestine an opportunity to adapt itself to the newly-added bulk. From not attending to this point an injection may fail in bringing away the fecal contents of the rectum, which contracts quickly and strongly under the stimulus of a distension suddenly established. On the other hand, when some medicament is intended either to exercise a local and continuous action upon the mucous membrane, or to affect the system by absorption, the quantity should be moderate, from one to three ounces. Thus an efficient anodyne is an injection of an ounce of mucilage containing twenty or thirty drops of the tincture of opium.

By reason of the large number of veins about the rectal walls, absorption takes place rapidly, and therefore we can obtain a more decided impression upon the system in this manner with an equal quantity of opium than when it is given in the usual way by the mouth. Cubebs, quinia, and other remedies may be administered in the same manner.

A patient may be kept alive several weeks by nutritive injections alone, such as broths, soups, solutions of gelatine, and albumen. But none of these articles can supply the absorbents with those elements taken up by them from food which has passed through the intestinal canal and become thoroughly impregnated with its secretions, so that beyond the period stated a person must inevitably perish unless other

sustenance be introduced into the stomach. It has been suggested that the addition of pepsine to these injections may contribute in some degree to give them the character of digested food.

Hard lumps of stercoraceous matter or hemorrhoidal tumors may prevent the fluid from passing into the bowel, or, as O'Byrne has shown, feces may collect in the sigmoid flexure of the colon, beyond which the ordinary clyster pipe could not throw the injection: in such cases as these a long tube, such as is found in connection with the stomach pump, must be introduced above the point of obstruction, and the enema injected through this. With care a flexible tube two feet long can be passed into the colon.

In constipation, with a relaxed condition of the mucous membrane of the bowel, injections of cold water, either alone or with the addition of a tablespoonful of common table salt, a little molasses, or a quantity of soapsuds, will give great relief to the patient, and suffice to secure the discharge of a normal quantity of feces daily. In some cases, again, warm water will be found preferable to cold.

When a powerful action is desired to be exercised, an injection containing the oil of turpentine may be had recourse to; such a one will be found in the ordinary purgative enema of the Pharmacopœia.

In chronic diarrhœa and dysentery, injections of solutions of the nitrate of silver, terchloride of iron, and the sulphates of copper and zinc may often be advantageously used.

It should not be forgotten that in employing large enemata the rectum may be distended to such a degree as to paralyze its contractile power so that the fluid will not be passed until a tube is inserted into the anus for that purpose.

The too frequent use of injections and suppositories may favor, or even induce hemorrhoids, or some organic change of the rectum.

Suppositories are composed of some fatty matter or other adhesive material incorporated with any remedial agent. The common purgative suppository is a piece of brown soap cut into a cylindrical shape and of suitable size to be introduced beyond the sphincter; catharsis results from its irritating the lower portion of the rectum.

If the aim of the practitioner is to introduce a medicament into the circulation, it should be reduced to powder and brought to the proper consistence with lard or butter, and then moulded into an ovoid mass.

The suppository can be most conveniently placed in its proper position by means of a small glass syringe, which resembles a penis syringe with its nozzle cut off and the margins of the glass well rounded, so that the sphincter may not be wounded.

The following are common forms of prescription for enemata and suppositories:—

℞.—Ol. olivæ f℥j;
Magnes. sulph. ℥ss;
Sacchar. alb. ℥j;
Sennæ ℥ss;
Aquæ bullientis f℥xvj.

Infuse the senna for an hour in the water; then dissolve the salt and sugar; add the oil, and mix them by agitation. (*Ed. Pharm.*)

A laxative enema.

℞.—Sodii chloridi ℥ss;
Adipis ℥j;
Fæcis sacchar. f℥j;
Aquæ fervent. Oj. M. f. enema.

This is the mild laxative enema of domestic practice.

℞.—Extract. colocynthid. ʒss;
Saponis mollis ℥j;
Aquæ Oj.

Mix and rub them together. (*Lond. Pharm.*)

A powerful purgative injection in colic and constipation.

℞.—Tinct. opii ♏xxx;
Decoct. amyli f℥iv.

Mix them. (*Lond. Pharm.*)

This enema is used in strangury, obstinate vomiting, diarrhœa, dysentery, and in painful diseases of the kidneys and bladder.

℞.—Ol. terebinth. f℥j;
Vitelli ovi No. j;
Decoct. hordei f℥xix.

Rub the oil with the yelk, and mix the decoction with them. (*Lond. Pharm.*)

A stimulating purgative enema.

℞.—Aloes ℈ij;
Potass. carb. gr. xv;
Decoct. hordei Oss.

Mix, and rub them together. (*U. S. Pharm.*)

This enema is employed in amenorrhœa attended with constipation, and ascarides.

℞.—Assafœtidæ prep. ʒj;
Decoct. hordei Oss.

Rub the assafetida with the decoction gradually added, till they are thoroughly mixed. (*Lond. Pharm.*)

This is gently laxative, carminative, and antispasmodic.

℞.—Aloes,
Sodii chloridi, āā gr. xv;
Mellis q. s. M. f. suppos.

An active purgative suppository.

℞.—Pulv. opii gr. ¾;
Butyrei ʒijss. M. f. suppos.

An anodyne suppository.

℞.—Quiniæ gr. xv;
Butyrei ʒiss. M. f. suppos.

An antiperiodic suppository when the stomach will not bear the quinine. (Boudin.)

Injection into the Cellular Tissue (hypodermic injection).—This is a practice which has only been introduced within the last few years, and during that time the repeated experience of the profession has sustained it as a very valuable means in the treatment of obstinate cases of neuralgia and many other painful diseases. The same plan has also been suggested for the purpose of bringing in contact with the interior structure of tumors, and other morbid growths, various irritating and caustic agents, to destroy them either by their direct chemical action or the succeeding inflammation.

The hypodermic injection is effected with a small syringe of glass or gutta percha (Fig. 72), armed with a long, hollow, needle-like nozzle for perforating the skin. It is intended to hold about one drachm, and the piston-rod is graduated, that the dose may be accurately determined.

Fig. 72.

Hypodermic syringe.

The operation is easy; the practitioner pinches up with the fingers of the left hand a fold of the skin, and with his right enters the point of the syringe into its base, either by a rotatory movement or a quick stab. When the puncture is accomplished, the skin must be permitted to resume its normal position, when the fluid must be slowly thrown from the instrument by pressing down the piston.

Annoying abscesses in the cellular tissue often succeed to this little operation, and is about the only unpleasant accident attending it.

Absorption of the fluid occurs rapidly, and if it contains an anodyne in solution, its action is soon manifested upon the system by a marked alleviation of the pain.

The narcotic solution usually employed consists of an ounce of water containing a grain of morphia; of this one drachm should be introduced twice a day. The alkaloids —aconitine and atropia—may also be employed in solution in the doses of one-thirtieth to one-fortieth of a grain.

It has been proposed to destroy cancerous tumors by thrusting the needle of the hypodermic syringe an inch or more into their substance, and throw into it thirty to fifty minims of dilute acetic acid, one part of the acid to two of water. The suggester of this plan, Dr. W. H. Broadbent, of London, states that "his aim had been not necrosis of malignant tumors, but a modification in their nutrition. The theoretical grounds for this hope were, that cancer owed its malignancy to its cellular or (to use a nomenclature now almost antiquated) fœtal structure; and that in acetic acid we had an agent which might be expected to diffuse itself through the tumor and reach the cells, and, having reached them, to effect changes in their structure, and affect them vitally, while it could scarcely do harm."

Injection of Abnormal Canals.—Long and sinuous passages running under the skin and among the deeper tissues may often be traced out, and solutions of various medicaments brought in contact with their walls.

The syringe which I employ for this purpose has a capacity of about two ounces, is made of glass, and supplied with a number of hollow, flexible stems of soft lead eight inches long, and of various sizes, each capable of being attached or detached from the syringe at pleasure.

The operation consists in introducing these metallic tubes, bent into the proper shape, into the sinus, and injecting the fluid against any desired point; or it may be distributed along the entire course of the canal.

CHAPTER VI.

ON THE USE OF GASES AND VAPORS.

In this chapter it will be our object to consider the various methods in which certain vapors and gases are used by the profession as remedial agents in the cure and prevention of disease.

Some of these agents are applied to the exterior of the body, either to its whole extent or to a limited portion of it. In the first instance the operation is called general, and in the latter local fumigation. The application of other agents is restricted to the bronchial mucous membrane, and constitutes what is technically known as inhalation; while a third class embraces those articles which are disseminated in the air with a view of purifying it, or destroying any noxious effluvia that may be contained therein, and become the cause of disease. When these vaporous agents act chemically upon the morbific constituents of impure air—that is, destroying them by forming new and inert compounds—they receive the name of disinfectants; while those which simply mask unpleasant odors are termed deodorants. Of the first kind we may mention, as a good type of the whole class, chlorine, which disinfects by combining with the hydrogen of sulphuretted hydrogen and its compounds; of the second kind, the vapor of vinegar and eau de cologne diffused through the air of the sick-chamber may be instanced.

SECTION I.

PURIFICATION OF THE AIR OF HOSPITALS AND CHAMBERS, OR DISINFECTION.

The subject of disinfection is one of the greatest importance to the medical practitioner, and demands a close investigation as to the real extent of its usefulness, and how far it may be relied upon as accomplishing the object for which it is employed.

There can be no doubt that in a widely-spread epidemic its influence is very slight, if at all appreciable, and is far inferior, as a preventive means, to other sanitary measures, especially cleanliness. Thousands of experiments with the various reputed disinfectants, extending over a space of time of more than a century, have been made in many parts of the South of Europe in numerous and fatal epidemics; and the conclusions from them seem to be, as stated above, that little or no reliance can be placed upon this class of agents.

The atmosphere may be rendered impure by such gases as carbonic acid, sulphuretted hydrogen, nitrogen, &c., which analysis makes known, and chemistry suggests and supplies the appropriate agents to destroy them; but, unfortunately, in a majority of cases such a strictly scientific course cannot be pursued, for the reason that the

presence and nature of most morbific causes diffused in the atmosphere have as yet remained undiscovered by any chemical tests, however delicate. Such, for instance, are the contagious principles of the exanthematous fevers, hospital gangrene, and typhus fever; hence, the use of disinfectants in such cases is based upon purely empirical practice.

These abnormal elements in the air have been variously termed emanations, miasms, malaria, and fomites—names that are simply used to designate phenomena of which we are altogether ignorant.

Some of the simpler cases of atmospheric impurity arise from well-determined causes, as a diminution of the natural proportion of oxygen in the air surrounding vats where the acetous fermentation is taking place. In this instance, the only remedy is to remove the cause. Carbonic acid is largely liberated under the same circumstances, and also from plants during the night; it is found in wells and caves originating from the decomposition of the surrounding soil. Quicklime and lime-water are the proper corrective agents in these cases, as they will absorb carbonic acid to a considerable extent. Dupuytren long ago suggested the plan of lighting two fires, one above the other, in the mouths of old wells, to displace the carbonic acid by the strong current of air thereby produced. The custom of lowering burning braziers into wells is based upon the same principle.

In the neighborhood of sinks and latrines, sulphuretted hydrogen, hydrosulphate of ammonia, and nitrogen, are found diffused through the air, and may be destroyed by chlorine, or the nitrate of lead (Ledoyen's Disinfecting Fluid, composed of eight ounces of the nitrate dissolved in a gallon of water), the former decomposing them by abstracting their hydrogen, and the latter, their sulphur: the resulting compound, in the first instance, being chlorohydric acid, and, in the second, the sulphide of lead.

Various other disinfectants are sometimes employed with a view of decomposing or destroying those atmospheric poisons upon which many contagious and epidemic diseases are supposed to depend. As stated before, their use in such cases is purely empirical, and their asserted efficacy very doubtful.

Chlorine and its compounds are had recourse to, perhaps oftener than any other article, for this purpose. The chlorine may be obtained very easily from a mixture containing one ounce of the black oxide of manganese, three ounces of common salt, one fluidounce of sulphuric acid, and two fluidounces of water. These materials must be placed in a saucer or other like vessel; a number of these saucers thus prepared may be put at intervals in the wards of a hospital or other apartment to be disinfected. The same result may be obtained by using the chlorinated lime in dishes, or sprinkling Labarraque's Solution—the *Liquor Sodæ Chlorinatæ* of the Pharmacopœia—upon the floor and upon the bedclothes of the patients. In either case a sufficient quantity of the chlorine should be developed to produce a decided odor of that gas, and never enough to cause irritation of the bronchial tubes.

I have employed, as a means of purifying infected ships, a mixed

gas of *chlorine* and *hydrochloric acid*, obtained by burning chloroform and alcohol together in the proportion of two parts of the former to one of the latter. The mixture is placed in a shallow saucer, and a piece of cotton cloth immersed in it to serve the purpose of a wick. When a lighted candle is applied to a projecting end of the cloth it takes fire, and the chloroform burns with a dense black smoke, very irritating to the conjunctiva and the bronchia. For this reason it could not be used in apartments where the sick are lodged, but for purifying empty hospital wards or a ship, nothing can be better than this. The plan I usually adopted was to set fire to several dishes of the mixture, placed at different points in the apartment, and then close up all the windows, doors, and hatches for three or four hours. After which everything is again thrown open to permit the free circulation of fresh air.

Chlorine was first employed as a disinfectant in France upon the strength of a statement made by the celebrated chemist Guyton de Morveau, that it possessed the power of destroying all animal miasms. About the same time, Smith, in England, brought forward nitrous acid gas as a disinfectant, which shared the great reputation of chlorine as an agent for the same purpose. The nitrous acid gas may be obtained by heating together in a saucer, placed upon a sand-bath, four drachms of nitrate of potassa and two fluidrachms of fluoric acid.

Ozone has also had its share of praise as a purifier of infected air. Dr. Moffat, in a paper read before the British Association, in 1862, stated that he had employed phosphorus for obtaining ozone, and had found it a valuable disinfectant during its luminous state, which he discovered to be much influenced by certain atmospheric conditions; a high pressure, low temperature, and the wind from the northern points of the compass being the conditions of its non-luminosity, and the reverse ones those of its luminosity. He describes his plan of using phosphorus in the following manner: "I take a quart bottle with a wide mouth, into which I put rather more than half a pint of water; a piece of cork carrying a flat piece of phosphorus with a clean cut surface, floats upon the water. The mouth of the bottle is loosely covered with a card. The bottle is then placed first in one part, and then in another of the apartment to be purified, until the peculiar smell of ozone is detected, or until my test-papers indicate 1 of my ozone scale. The process of purifying may be performed night and morning, or oftener. For purifying air in the neighborhood of street gratings or in sewers, I simply suspend a piece of phosphorus from the grating. In apartments the temperature may be sufficiently high to keep phosphorus luminous under all atmospheric conditions; but in sewers it will be luminous or non-luminous, according to the height of the barometer, the temperature of the surrounding air, and the direction of the wind, and ozone will be produced only when it is luminous."

The vapor of iodine has been tried in England, with a certain amount of success, diffused through the air of the sick chamber. According to Righini it possesses remarkable antiseptic and antispasmodic properties, and is a valuable hygienic resource in hospitals.

He recommends that it be employed in the following manner: A soft paste is made by moderately heating sixteen parts of starch in a sufficient quantity of distilled water, and stirring them with a wooden spatula. Eight parts of iodoform having been added, the mixture will be found to be readily absorbed by filtering-paper. The paper prepared in this way is cut into strips three or four inches wide, and suspended in the wards. The iodoform slowly escapes without causing any inconvenience to the inmates. It is most freely liberated in moist states of the atmosphere. M. Righini recommends iodoform paper for the purpose of obviating the bad smells and noxious effluvia of slaughter houses, and also for preserving meat from spoiling.

Sir William Burnet's disinfecting fluid is a solution of the *chloride of zinc* in water, in the proportion of twenty-five grains to one fluid-ounce. In using it, one pint of the fluid may be mixed with five gallons of water. Its power is limited to the decomposition of sulphuretted hydrogen and hydrosulphate of ammonia.

The *permanganate of potassa* is a valuable disinfectant, acting by decomposing the noxious gases; it is itself insipid and inodorous, which is a further commendation of this truly efficient agent in surgical practice. It may be employed either in solution or in powder mixed with starch or carbonate of lime; a few applications of the remedy to grayish-colored and fetid ulcers, or gangrenous wounds, will entirely remove the bad smell and restore a roseate color to the diseased tissues. Injections of the permanganate may be made in cancerous affections of the uterus, and in chronic ulcerations of the mucous membrane of the nasal fossæ, with advantage.

Sulphurous acid gas was very anciently employed as a disinfectant, and is mentioned by Homer. It may be obtained by burning sulphur in an open vessel, or by applying heat to a mixture of mercury and sulphuric acid contained in a retort. MM. Kurz and Manuel recommended that the streets of Paris should be fumigated with the sulphurous acid gas during a malignant and widely spread epidemic of cholera.

The *bisulphite of soda* and the *sulphite of soda and lime* enjoy similar properties with the sulphurous acid.

Cheap disinfectants for throwing into latrines and for covering up masses of decaying animal and vegetable matters, will be found in common quicklime, and the powder of MM. Corne and Demeau, which consists of 100 parts of sulphate of lime and three parts of coal-tar.

Carbon, in the form of smoke, is often used by sailors to disinfect ships; its efficacy is materially enhanced by the presence of a small quantity of creasote, which is always present among the products of the combustion of wood.

We cannot properly consider the explosion of gunpowder and the making of large fires in infected localities as possessing disinfecting properties. They can act in no other way than by causing a movement or circulation of the air, from which little assistance could be expected under any other circumstances than dislodging carbonic

acid or other gaseous agents from wells or excavations. M. Balcels, a chemist of Barcelona, suggested that cinnabar and the oxide of arsenic be added to the gunpowder before explosion.

The vapors of *vinegar, acetic acid, camphor,* and the *resins* should rather be regarded as deodorants than as disinfectants.

For the purpose of purifying the garments of the sick, the Hebrews depended largely upon the copious use of fresh water, and doubtless this agent, unassisted, will suffice in many cases; but the operation will be very much more certain and speedy in all cases by the use of steam at 200° or even higher. Dry heat will answer the same purpose, but it is apt to damage the texture of the clothes.

When water is employed in cleansing infected wearing-apparel and bedclothes, the addition to it of lime-water or the solutions of the bisulphite or hypochlorite of soda will facilitate the acquisition of the object in view.

M. Balcels had recourse first to a solution of the pernitrate of mercury in water, in the proportion of one part of the former to seventy parts of the latter, and then fumigated the clothes with chlorohydric acid gas.

Disinfection naturally includes the action of antiseptics, and the latter, therefore, need a passing notice. The antiseptic most frequently employed in hospital gangrene and sloughing sores or wounds is the permanganate of potassa in solution, in the proportion of five parts to fifteen parts of water.

A piece of fine linen wrung out of a solution of the chloride of soda (Labarraque's solution), and 'laid over the parts, will correct the fetor of profusely suppurating wounds.

Bromine has been much used, of late, for the purpose of arresting the progress of hospital gangrene, and is considered an effective agent. It may be applied with a camel's-hair brush.

Carbolic acid, an oily liquid obtained by distilling coal tar and quicklime together, resembles creasote in its antiseptic properties, contracting and hardening the animal tissues, and protecting them from putrefaction.

A concentrated solution of the bisulphite of soda, injected into the arteries, will preserve a subject from decomposition six or eight weeks in the warmest weather.

Ammonia, in the form of vapor, possesses antiseptic power to a considerable extent; it acts catalytically, by preventing oxygen combining with oxidizable matters. In employing this agent for the preservation of organic substances, it is important to exclude all other antiseptics before or during the time the specimen is being exposed to the vapor. The only apparatus needed is a simple jar, in which the substance to be preserved is suspended, having previously introduced into it about a drachm of strong liquid ammonia; then render the jar hermetical by a luting of soap or a mixture of soap and red lead. For the preservation of fluids, ammonia may be added to them in the proportion of ten to twenty minims to the ounce.

Cleanliness, both of the apartments and the clothes and person of

the sick, will do more towards preventing the rise and progress of disease than any amount of disinfection.

The rooms in which the sick and wounded are lodged should be scrupulously cleansed; the floors well scrubbed, but never flooded with water, as is sometimes done, particularly in the "sick bays" of our men-of-war. The simplest plan to avoid this is "dry scrubbing," which consists in using a brush and sand only, and subsequently sweeping the floor with a broom; or, again, the scrubber may use a brush and hot water, drying apace as he proceeds. The walls should be covered with whitewash, which, though it may not act as an absorbent of pernicious miasms, as some have supposed, will, nevertheless, be advantageous by keeping them clean, and diffusing around a feeling of cheerfulness.

All vessels containing slops, soiled dressings, and offensive discharges ought to be removed at once from the room, and a free circulation of air kept up in it. This may be accomplished by opening the windows and doors in summer; in winter, a fire built in the chimney-place will cause a current from the crevices of the doors towards the fire and up the chimney.

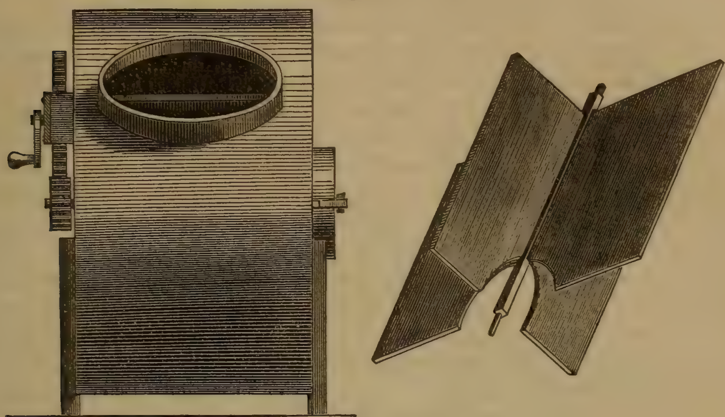
On board of ships, ventilation is a matter of the greatest moment to the health of the crew, who are usually crowded during the night into a very restricted space; and were it not for the numerous hatches almost always kept open, serious consequences to the health of the men would certainly result. In the construction of the English hospitals and barracks, 1200 cubic feet of breathing space is allotted each man, which is far greater than the allowance in our war vessels, aboard of which, by an injudicious system of bulkheads, but one person, the captain, of the whole complement has, during sleep, a sufficiency of that health-sustaining element, pure air.

For the purpose of ventilating the apartments below decks, air-chimneys, or windsails, as they are called, are used, and sometimes specially constructed machines, such as the ventilators of Hales, Brindejonc, and Souchou.

The figure from Fonssagrive (*Traité Hygiène Navale*) shows the ventilator of Brindejonc (which is one of the best), by which the foul air of apartments either in hospitals or in ships, may be driven out. It consists of a cylinder 25 inches in height, having two parallel bases of 3 feet 3 inches in diameter. One of these bases is provided with a toothed wheel of 12 inches in diameter, having fifty-two teeth, and supporting at its centre a crank; this wheel turns, when it is in motion, a little cog armed with thirteen teeth, and to the centre of which is fixed a stem with the four wings of the ventilator. The other base has at its middle a circular opening of 11 inches, traversed diametrically by a small iron bar which is used as a *point d'appui* to the axis. Upon one of the points of the circumference of the cylinder there is an elliptical opening, having 19½ inches in its transverse diameter, and 11 inches in its vertical axis, through which the air comes out. The ventilator is arranged with four wings, cutting each other at right angles. When the toothed wheel is put in motion by the crank, it catches upon the little pinion, and turns the wings rapidly;

the air is introduced through the circular opening at the base, and issues forcibly from the elliptical opening upon the side of the cylinder.

Fig. 73.



Brindejonc's ventilator.

In connecting the machine with the air of apartments and that externally, we employ stiff cylindrical pipes made of canvas, and of the necessary length.

With a small five-horse power steam-engine, 25,000 cubic feet of fresh air, heated to an appropriate temperature, can be driven per minute through the wards of the largest hospital, and in all our steam war vessels this plan should be adopted, particularly in those cruising in hot latitudes. It has been found efficient in the iron-clads, and quite as great a necessity exists for a good system of ventilation in other classes of vessels.

SECTION II.

THE APPLICATION OF VAPORS AND GASES TO THE SKIN.

1. Fumigation.—We have already described the manner of applying aqueous vapor to the skin, under the heading of vapor bath, and we have, therefore, nothing further to say of it in this place.

Other vapors are also used, either dry or moist; their action, like the aqueous vapor, partly depends upon their heat, humidity, and density, but in general they also possess some special therapeutical activity, either locally or being absorbed generally; in the latter case the whole system is more or less influenced by them. Thus the vapor of water may be rendered more emollient by the addition of some bland substances, such as marshmallow; or, what is more often the case, stimulating and alterative by combining it with the vapors of alcohol or the mineral acids. Sulphur, the volatile oils, camphor, benzoic acid, the resins, and gum resins are volatilized by throwing them upon hot metallic plates placed beneath an apparatus by which the patient is

surrounded; they have an action similar to that of the preceding medicaments.

Of the articles absorbed into the circulation, the most frequently employed are the compounds of mercury, and their use by fumigation in the East Indies dates back to a very remote period. They are still much used by the native practitioners in the treatment of obstinate skin diseases and syphilis. In skin disease, the quantity of the sulphide of mercury, of cinnabar, of black oxide, or of the common mercurial ointment employed at one fumigation, is from a half to three drachms, and of sulphur half an ounce volatilized upon a hot iron plate placed beneath a blanket supported on hoops and surrounding the patient's person. If he is out of bed, a common box or hogshead, with a hole cut into it for the head to be protruded that the vapors may not be breathed, will answer the same purpose.

A higher temperature of a dry gas may be more easily borne than a lower one of a humid gas, for in the latter case the transpiration will be arrested, and the patient will, therefore, suffer greatly from a sensation of internal heat and oppression, and soon become exhausted. The difference in the action of moist and dry gas is shown in the experiments of Drs. Fordyce and Blagden upon heated air, by which it was demonstrated that a man might remain some time in an oven with a dry air heated to 350°; while air of the same temperature containing aqueous vapor could not be borne.

The classes of cases in which fumigation is employed are chronic rheumatisms, syphilitic affections, and inveterate skin diseases.

Sometimes the application of the vapor is limited to restricted portions of the body by means of boxes of a sufficient size to surround them. In this way, chronic inflammations of the joints, periostitis, and ulcers have been treated. M. Dumarquay has succeeded in relieving pain, in checking fetid secretions, and sometimes in healing ulcers, by surrounding the parts with an atmosphere of carbonic acid.

2. THE APPLICATION OF HOT AIR TO WOUNDS.—M. Jules Guyot suggested the unique method of treating wounds by immersing them in an atmosphere of heated air, and which he designated as the method of curing wounds by "incubation" (par incubation). The plan is founded upon the observations of surgeons in hot climates, that wounds healed more quickly under an elevated temperature than the reverse. This is strikingly illustrated in the influence of our high summer heats over the adhesive process, which takes place much more surely than in cold weather and damp cool latitudes. The same thing is observed in the constitution of the Arab, whose climate, active habits, and diet produce a spare and sinewy frame and a sort of dry temperament very favorable for the quick healing of wounds. I have made the same observation in some parts of the East Indies where the population is under analogous influences. In the Gulf of Mexico the heat during the summer is excessive; and it was during a period of this sort of weather that I received into the hospital under my charge, at the mouth of the Mississippi River, a large number of the wounded during the naval operations against New Orleans. Though the buildings were crowded with the wounded and fever patients, all of the wounds

healed with unusual rapidity; and of fifteen cases of amputation of the thigh and arm but two died, both of them after secondary operations, one of the patients having lost a good deal of blood from having his knee shattered by a rifle shot; in the other case, disarticulation was performed at the shoulder for a gunshot wound of both the axillary artery and vein.

Rochard, in speaking of the healing of wounds in hot climates, says: "All of our confrères point out the rapidity of their course and the promptitude with which they heal. I have myself been able to verify it often at Madagascar. The bad guns of which the Sacolares made use often burst in their hands, and I have seen some of these complicated wounds, for which I had proposed amputation, heal with a wonderful facility, in spite of the most irrational treatment. Intertropical climates are favorable to the efforts of conservative surgery; and operations, when it is impossible to avoid them, succeed better there than in Europe. The same observation has been made in Oceanica, on the coast of Africa, in South America, and in the Antilles. It explains the almost constant success of the amputations of naval surgeons on equatorial stations, and the remarkable cures that they often obtain when it is possible to abstain from them."

The incubative apparatus of Guyot was invented for the purpose of placing wounds under these identical conditions as found in hot climates. It consists of an oblong box about fourteen inches long, twelve inches deep, and twelve inches wide, with its extremities open, and having tacked around the margins of each a piece of muslin a foot wide, and furnished at its unattached border with an elastic cord to closely embrace the limb. The lower wall of the box is double, the upper partition dividing the box into two parts, an upper and larger one and a lower one; these communicate with each other by means of two narrow grooves in the lateral walls of the box, while the smaller compartment is connected with the external air by means of an elbow-tube, under the external extremity of which, shaped like a funnel, a spirit lamp is to be placed. The upper wall of the box must be a glass plate, that the condition of the inclosed limb may be always under observation; and the bulb of a small thermometer is placed inside the box, with its stem projecting exteriorly, so that the temperature of the inclosed air can be ascertained at any moment.

The apparatus above described is that directed for wounds of the lower extremities; but Guyot proposes a number of others, constructed upon the same principle, to be used for the arms, shoulder, hip, and even for the whole body.

The wounded part must be inclosed in the apparatus in such a manner that the movements of the patient or the involuntary contractions of the muscles may not disturb it, or, if it be a stump, pull it from the box.

Guyot, in his practice, sustained the air within the box at about 81° Fahr. M. Robert employed the apparatus extensively in the treatment of wounds, ulcers, and a large number of surgical diseases; and advised that in recent injuries a period of twelve hours should be permitted to elapse before applying it.

Velpeau states that he has made some trials with the apparatus in his department in the hospital of La Charité, but they have been neither sufficiently numerous nor varied to allow of his giving an opinion of its value.

SECTION III.

THE APPLICATION OF GASES, VAPORS, AND ATOMIZED LIQUIDS TO THE INTERIOR CAVITIES.

INHALATION.—The simplest method of influencing the bronchial mucous membrane by vaporous remedial agents is to diffuse them through the atmosphere of the patient's apartment; in this manner we use burning tar and paper saturated with a solution of the nitrate of potassa. It has been proposed to conjoin some of the narcotics with the nitrate of potassa—for instance, belladonna, stramonium, digitalis, and lobelia; the materials may be mixed with paper pulp, and moulded into pieces of suitable size, one of which may be burnt in the chamber of a patient, in the evening, during an asthmatic paroxysm.

Some, again, prefer to smoke the dried leaves of the stramonium plant in a pipe, or to have them cut fine and rolled up in imitation of cigarettes. The following formula will show how the cigarettes may be prepared:—

℞.—Fol. belladonnæ gr. iv;
Fol. stramonii,
Fol. hyoscyami, āā gr. ij;
Fol. phellandrii gr. jss;
Extr. opii gr. $\frac{1}{4}$;
Aquæ lauro-ceraci q. s.

Dissolve the extract of opium in the cherry-laurel water, and, having cut the leaves fine, mix them with the solution, and roll them up in paper also previously moistened with the laurel-water and dried. (Jamain.)

Two or three of these cigarettes may be smoked each day during an attack of nervous asthma.

Raspail recommends the inhalation of the vapor of camphor, small fragments of which may be placed in a quill for that purpose; it is vaporized by the warmth of the palm of the hand in which it is held. He says it relieves catarrh, obstinate cough, and the paroxysms of asthma.

Special instruments, called inhalers, are sometimes employed for this purpose, an old form of which is that designated as the Mudge inhaler, consisting of a pewter pot with a cover to which a flexible tube and mouthpiece are attached; but a more useful and convenient inhaler may be easily prepared in the following manner: Get of any tinner a cylindrical tin vessel about ten inches high and three and a half to four inches in diameter; inside of this have another tin vessel, half the length of the former, fitted and resting upon its edge by a narrow rim; three-quarters of an inch from its bottom there is a projecting ledge to support a double tubulated glass jar to contain the fluid to be inhaled. One of the tubulures is fitted with a cork supporting a glass tube to permit the entrance of air to the jar, and a slim thermometer to indicate the temperature of its interior; to the other

tubulure a flexible tube and mouthpiece are attached, through which the patient inhales the vapor from the interior of the jar. The inner tin vessel contains water, and serves the purpose of a water bath, being heated by a spirit-lamp placed beneath it, through a large aperture cut into the outer vessel near its bottom. With this simple inhaler any volatile substance dissolved in water, and placed within the glass jar, may be brought in contact with the bronchial mucous membrane.

A still less expensive inhaler may be prepared, represented in Figs. 74, 75. It consists of a wide-mouth jar fitted with a cork, through which two glass tubes pass to the interior of the vessel. Through the bent tube the patient inhales the vapor rising from the liquid in the jar, while the other tube, projecting below the fluid, admits the air from the exterior.

Fig. 74.

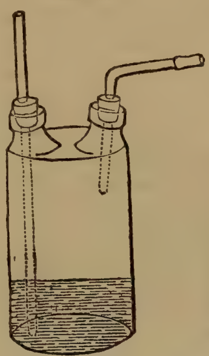


Fig. 75.

Inhalers.

By the addition of geum, marshmallow, slippery-elm bark, elder flowers, &c., to the water, emollient vapors are obtained, which are very soothing to the irritated bronchial tubes; a few drops of any of the volatile oils, or tincture of guaiacum, render the vapor stimulating, while opium, belladonna, and hyoscyamus confer calmative properties.

A simple plan of inhalation, often employed in domestic practice, is to reverse a funnel over the vessel containing the liquid, and through its smaller end the patient draws the vapor, by placing it in his mouth and making deep inspirations. M. Righini states that the inhalation of iodoform dissolved in ether is of great service in retarding the progress of phthisis.

A teaspoonful of chlorine water to a pint and a half of water, placed in the inhaler and respired three or four times a day, according to the tolerance of the patient, once enjoyed a high reputation in the treatment of phthisis and other pulmonary diseases. Sir Charles Scudamore used, as he thought with advantage, in similar cases, the vapor of iodine. Indeed, the whole class of volatile medicines has been tried from time to time in the treatment of the various affections of the lungs, sometimes with advantage, and at others fruitlessly.

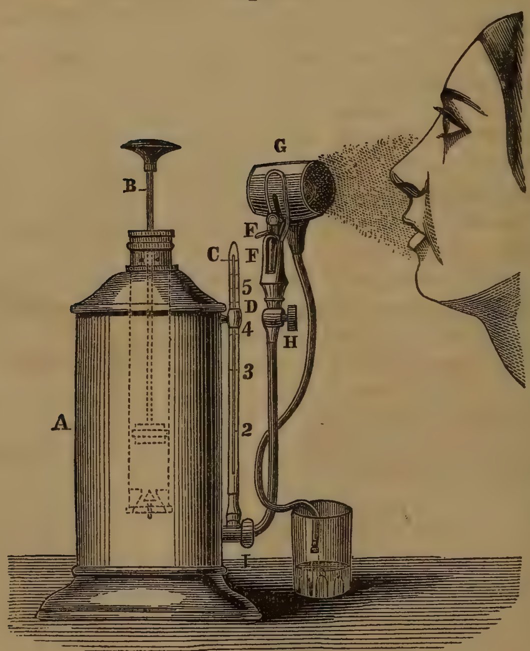
The idea of inhaling oxygen was long ago spoken of by Sir Humphrey Davy, and in 1804 Dr. Eddoes had conceived the propriety and utility of the same method of medication. Dr. R. H. Goolden, of London, has made some experiments lately with this agent, and adds his testimony to its advantages in phagedenic ulceration of the throat and in chronic gout. He employed a large vulcanite bag, with a tube, stopcock, and mouthpiece, which was filled with a mixture of oxygen and air in the proportion of one to four. The gas is inhaled by the patient and expired into the atmosphere. The administration may

be made for half an hour each day, the gas being slowly inspired at intervals, and filling the lungs as much as possible.

Inhalation of Atomized Fluids.—More recently, a new method of inhalation has been introduced into practice, that of employing atomized remedial agents in the treatment of thoracic diseases. It consists in substituting for vapor solutions of certain substances in a finely-divided state, forming a mist or spray. This novel plan was first suggested by Sales-Girons, in 1852, and since that time has been employed by physicians both in Europe and America with decided success in relieving and curing many of the diseases of the throat and lungs. In fact the whole system may be affected by these inhalations, as sea-water used in this manner seems to exercise a decidedly beneficial influence on scrofula, particularly as it occurs in young subjects under bad hygienic influences in large cities.

The instrument by which the fluid is converted into spray is called an atomizer, the simplest form of which is seen in the common nursery tube, which consists simply of two glass tubes placed at right angles, and having their approximating ends drawn out in small orifices; the tubes are supported in the above position by a metallic brace. In using the instrument one of its legs is immersed in fluid, and the person blows forcibly through the other, by which operation

Fig. 76.



Atomizer of Sales-Girons

the rapid passage of the air through the horizontal tube over the open orifice of the vertical tube produces in the latter a vacuum which the

fluid in the cup rises to fill, and finally emerges at the orifice into the stream of air, and is there broken up by it into spray, and projected from the instrument some distance, according to the strength of the current of air.

As the operation performed in this manner would be objectionable, both on account of the fatigue it would be to the operator as well as the repugnance the patient would have to breathing air projected directly from another person's lungs, the elastic force of compressed air or of steam is employed for this purpose, and hence the use of two kinds of instruments. Of those in which a rapid current of compressed air is used, the instrument (Fig. 76) invented by M. Sales-Girons is the best, and, though somewhat complicated, yet it works beautifully. It consists of a glass jar, A, containing an air-pump, which exercises the requisite degree of pressure upon the fluid contained in the jar; C is the manometer for indicating the degree of compression; D is the tube through which the fluid escapes to pass to the drum G, inside of which there is a little metallic disk, placed obliquely, upon which the fluid strikes, to be atomized and then thrown by the drum towards the face of the patient; an elastic tube is put below the drum with an expanded end above to catch the drops of fluid which escape from the drum, and to carry them into the glass below.

The steam Atomizer, Fig. 77, consists of a small copper boiler with a rectangular tube attached to it, and furnished with an aperture at the top through which the water for making steam is introduced; this is

Fig. 77.

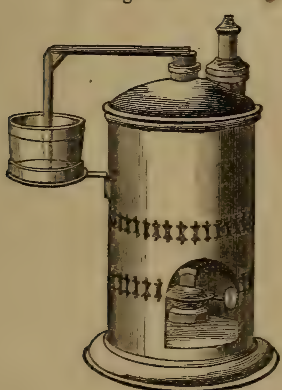


Fig. 78.

Steam atomizer.

closed with a common cork. Along side of this is a small steam valve designed to permit the escape of steam when the interior pressure rises beyond a certain degree. A small glass or porcelain cup is intended to hold the fluid to be atomized, and is placed so that the vertical tube may be immersed in it. To employ the instrument, place a spirit lamp beneath the boiler containing water, and when the steam begins to flow through the horizontal tube, the little cup with its contents must be put beneath the vertical limb, and immediately the liquid

will rise in the tube and become atomized in the current of steam. Fig. 78 shows the shield to protect the face from the vapor.

With the atomizer any substance capable of solution may be introduced into the lungs in the form of a spray. As an illustrative example we may employ carbolic or phenic acid, suggested some three years since by that eminent physiologist Dr. Longet in tuberculosis, of which he himself was a subject. The mode of administration is as follows: fifteen drops of pure acid are dissolved in ʒij of alcohol, and the solution mixed with ℥xij of water. This quantity may be atomized and inhaled daily.

Fig. 79.

Apparatus for applying carbonic acid gas to the uterus.

Besides the bronchial mucous membrane it is proposed also to bring the spray in contact with the lining membranes of the bladder, the vagina, and the uterus with specially constructed instruments.

M. Dumarquay, in his work on pneumatology, extols the advantages of the introduction of carbonic acid gas into the bladder in diseases of the genito-urinary organs, such as cystitis and vesical neuralgia. The vesical douche may be easily administered with a small caoutchouc bag filled with carbonic acid, which is thrown into the bladder through a common catheter; or Mondollot's apparatus may be employed, consisting of a double-tubed catheter and an India-rubber bag, which facilitates the escape of any gas in excess in the bladder.

The same author has also derived benefit from the carbonic acid douche in certain uterine affections—amenorrhœa, dysmenorrhœa, chronic enlargements, and simple ulcerations of the cervix.

It may be effected with the apparatus seen in Fig. 79, which consists of a common bottle having attached to its mouth an elastic tube about three feet long, provided with an ivory nozzle.

The materials to be introduced into the bottle for generating the gas are about a tablespoonful each of bicarbonate of soda and tartaric acid with six ounces of water.

CHAPTER VII.

THE "SECOND PIECES" OF DRESSING, OR BANDAGES PROPERLY SO CALLED.

We have already described the "first pieces" of surgical dressings, those which are intended for immediate contact with wounds. Sometimes they are the only dressings employed in the treatment of a case, but more frequently other pieces are required to retain them in a proper position; and it is to these that the technical term "second pieces" has been applied, or simply bandages.

Bandages are of three kinds, *simple, compound,* and *mechanical.* Simple bandages are formed by an entire roller arranged with various convolutions, and in different manners, and receiving distinctive names according to these differences. Compound bandages consist of two or more pieces of a simple bandage, either separate or sewed together in diverse manners. Mechanical bandages are more complex, and are generally formed of wood, metallic plates, levers, &c.; they are also designated as machines, apparatus, or mechanisms, and are principally employed in the treatment of fractures, dislocations, and distortions.

SECTION I.

GENERAL RULES FOR THE PREPARATION AND APPLICATION OF BANDAGES.

There are certain general rules which control the preparation and application of all bandages, and these will therefore require a general notice.

In the first place, all the pieces of a bandage to be applied should be brought together, and be at hand for immediate use, so that the dressing may not be delayed, after it is a third or half finished, for the want of some necessary article which has been overlooked or mislaid. The necessities of each case ought to be carefully investigated before the bandaging commences, otherwise it may be found that it will not answer all the indications presented, and thus not only will time be lost, but much unnecessary pain be inflicted upon the patient. Yet it does happen, in some cases of fracture, that the first apparatus will have to be changed or much modified before the patient feels free from pain; and it should never be forgotten that a bandage, causing continuous pain or uneasiness, inflicts more injury than can be counterbalanced by any good it may confer. Under these circumstances the patient would do better were he abandoned to his own ingenuity and the dictates of his own sensations.

All crowding around an injured person should be avoided, and only such assistants as the surgeon may deem necessary to aid him in the

accomplishment of his object should participate in the dressing. Their duties will be to supply promptly, as called for, the various articles that are wanted; to support the patient's limbs after he has been placed in an easy and convenient posture, and to raise him from the bed, or to shift his position as the surgeon may desire, and to maintain splints or other apparatus in their proper situation until properly secured. Each person assisting should have his duties assigned him before the operation begins, and under no circumstances should he depart from them, unless ordered to do so by the surgeon.

The bandage, in order to be effective, must be applied with regularity, that the pressure may be uniform everywhere; and a no less important precept is, to have such an amount of that pressure as the case demands, otherwise if the bandage is too loose, it will slip, and the object, therefore, will not be obtained; or, on the other hand, if too tight, the most deplorable consequences may ensue, as mortification of the parts compressed. The greatest attention should be paid to the bandaging of recent injuries before inflammatory swelling has occurred, and of fractures where we employ the immovable apparatus.

That the blood may not be arrested in the lower parts of the limbs, and give rise to congestion, œdema, or even gangrene, the bandage ought to be applied first to their distal extremities, and made to ascend gradually towards the trunk.

As to the material of which bandages should be fabricated, linen cloth is far preferable to any other; but from its high price, and the near approach to it in all useful qualities of cotton cloth, the latter is now most generally used.

Velpeau remarks of woollen cloth "that it would often be preferred to linen for bandages if it were less dear. Though we might for this purpose make use of any kind of woollen cloth, or stuff, we generally prefer flannel, and that almost exclusively, for woollen bandages. Pliable, porous, and resistant at the same time, flannel bandages have the advantage of adapting themselves exactly to the parts, and with very little tendency to become displaced, or to plait or roll up upon themselves; they also increase the temperature of the part, and readily absorb excreted fluids; they are very extensively used in England. There is, however, the objection, that they keep up a certain degree of irritation upon the skin, uselessly heat the parts, and soon become badly soiled; neither do they answer as well for the establishment of reverses as linen bandages, and are, besides, too distensible, and of a kind that cannot be readily had on all occasions."

Caoutchouc and gum-elastic bandages have also been used, and praised for their elasticity and the equability of their pressure; but these desirable qualities are more than counterbalanced by their impermeability to the cutaneous transpiration, and the difficulty of regulating the degree of pressure, as well as their expense and inaccessibility under ordinary circumstances; and for these reasons they have not come into general use.

Cambric and calico have also had their admirers, but they are objectionable for bandages, when new, because of the glazing, which readily permits the turns of the roller to slip; and when the sizing is

washed out, the material becomes thin and yielding, and rolls up in cords with extreme facility.

As the roller-bandage is an important element in very many surgical dressings it demands a special notice. The cotton cloth of which it is made should be of medium thickness, bleached, soft, and new; washing destroys to some extent its elasticity. It is torn into strips, from one to three inches wide, and from one to ten yards long, in the direction of the warp of the stuff. It is always desirable to have each roller in one piece, but in case of necessity a number may be tacked together in such a manner that their lines of junction may not produce wheals or excoriations. This may be avoided by overlapping the ends of two pieces for an inch, and fastening them together by what the sempstress calls the *cat-stitch,* which will place the threads upon the outer surface of the bandage, or they may be sewed together by a running stitch, and each end afterwards doubled back upon itself and secured by the *cat-stitch;* in this way both the stitches and the free ends will be upon the outside. The selvage should be removed from the edges of the strips; as it yields less than the balance of the cloth, the skin may be injured by its pressure. To prevent the threads from ravelling, it has been suggested to whip-stitch the edges of the strips, but it is far better to avoid this, as all the loose threads may be effectually torn away from the ends of the roller with the fingers.

In Germany, long, loose, light, and elastic strips are woven for surgical use, with a single horse-hair running along each edge under little loops, which is to be removed when the rollers are used; by means of the little loops the edges of the band yield equally with the balance of the material.

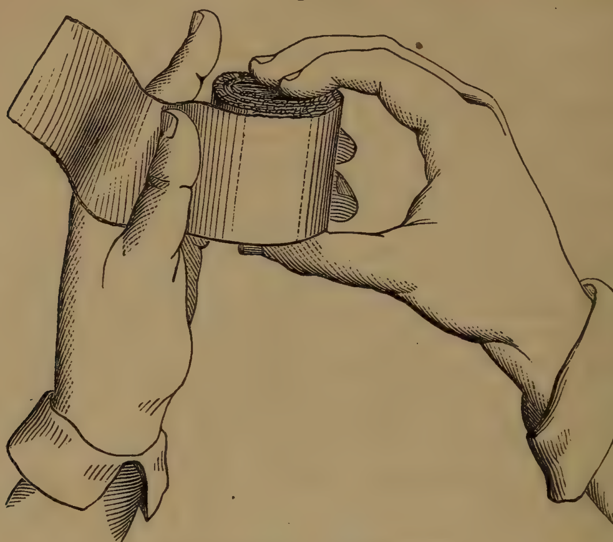
Strips are rolled up for the purpose of enabling the surgeon to apply them with rapidity and neatness. The rollers should be moderately firm and of a convenient size, so that the strip shall never be more than eight or ten yards long. A large roller is apt to slip from the hand and to interfere with the neat adjustment of the bandage. One is more likely to apply a roller too tight when it is hard than when it is in the contrary condition.

In ordinary cases the surgeon prepares the roller with his hands; while in hospitals, where large quantities of bandages are consumed, a little instrument called the *bandage-roller* is commonly employed.

To put up a roller with the fingers, select a strip of the proper length and width and double one end of it upon itself for eight or ten inches; repeat the operation with the doubled portion a number of times, until a small cylinder is formed, which should then be taken in the thumb and first two fingers of each hand and rolled upon itself until it assumes sufficient thickness to bear some pressure, when the cylinder must be held between the thumb and the second and third fingers of the right hand, that side of it facing the surgeon to which the free portion is tangent, and the unwound part between the radial border of the left hand and thumb; the last three fingers of this hand are extended under the cylinder, and by their pressure and the alternate supination and pronation of the left hand it is made to revolve

rapidly (Fig. 80). Should the hand supporting and tightening the wound portion of the bandage become fatigued, the other hand must

Fig. 80.

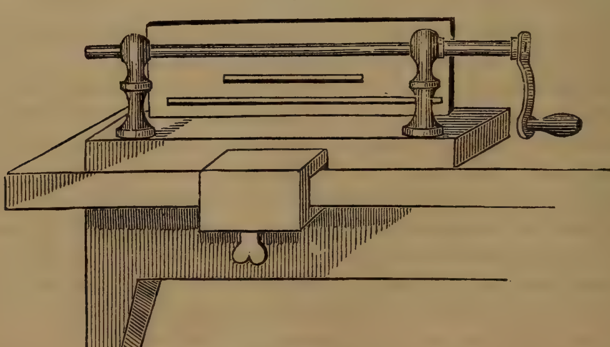


Mode of making a roller bandage.

be made to relieve it. At any time during the rolling, the turns upon the cylinder may be drawn firmer by simply holding it by its ends between the forefinger and thumb of the right hand, while strong traction is made upon the free portion with the left.

From the fact that the free end of the roller is first applied, it is called its "initial extremity," and the other end of the strip, now in its centre, the "terminal extremity," and the roller is said to be single-headed. When the strip is rolled from both of its extremities the

Fig. 81.



Bandage-roller.

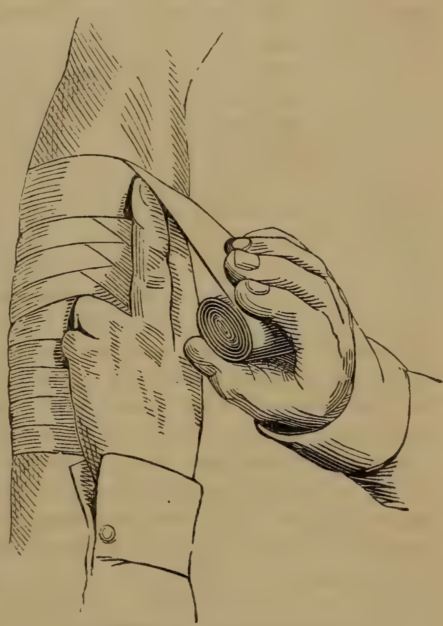
double-headed roller is formed, and that portion intervening between the two heads is called its "body," while both ends are then "terminal"

and at the centres of the cylinders. This roller is made in the same manner as described above.

The machine (Fig. 81) for rolling bandages is very simple, consisting of a metallic spindle supported upon two uprights or columns, and revolved by a crank; opposite the spindle there are two horizontal bars, or a board with two parallel slits cut in it, for the purpose of supporting and regulating the tension upon the strips. To render the machine stationary while it is being used, it is fastened to a table or bench with a large wooden screw and clamp.

The manner of applying a single-headed roller is to take it by its extremities between the thumb and the second and third fingers, or to hold it in the palm of the hand between the thumb and the four fingers; in either case, that part of the cylinder to which the free portion is tangent ought to look from the surgeon. Then unwind the initial extremity a little and lay its external surface upon that part of the circumference of the limb opposite to the injury, and hold it there with the point of the finger or thumb of the left hand, while two or three circular turns are being made to secure it from slipping. Now the turns may be successively applied, each covering in a half or two-thirds of the width of its predecessor, until the entire roller is exhausted. But owing to the conical shape of the limbs, a bandage applied circularly in this manner will press upon the surface by its superior border only, leaving the lower one standing off from the part, and forming pockets or puckers; to avoid these an oblique direction must be given to the turns, forming what are called *doloires,* each of which overlaps two-thirds of the one that precedes it; if they simply touch by their edges, the spiral is said to be *rampant.* The turns of a roller applied in this manner are apt to slip, and cannot be laid down smoothly enough upon a very conical part to make uniform pressure upon it, and we are, therefore, compelled, in order to avoid this inconvenience, to change its direction at every turn; in other words, to make what are termed "reverses." This is done in the following manner: When the roller has passed the point upon which a reverse is designed to be placed, a distance of five or six inches, the turn is held against the limb by the point of the index finger or thumb of the left hand, while, with the right, the roller is drawn backwards and folded

Fig. 82.



Mode of applying the roller bandage.

upon itself by pronating the hand, as seen in Fig. 82, so that the superior border of the turn becomes the inferior, and the external face the internal; the reverse must then be tightened by gentle traction upon the roller.

To give a neat appearance to the bandage, these reverses may be arranged in the same vertical line upon the limb; and to insure the greatest uniformity of pressure the oblique edges which they form by folding must not exceed the width of the roller, else they are liable to constrict the limb like cords.

The direction of the turns, as they are generally applied by a right-handed person, is from left to right, that is, from without inwards for the right leg and the reverse for the left leg; but this is entirely a matter of choice, for the best rule is, that that method of applying a bandage should always be selected which will insure the neatest and most efficient result.

In employing the double-headed roller, there is a little more difficulty, perhaps, encountered than in the previous case. Gerdy directs it to be accomplished in the following manner: "Seize the two cylinders in both hands, apply the external surface of the intermediate portion or body upon a point of the circumference of the part which the bandage is to cover; afterwards unwind at the same time and to an equal degree the two cylinders around the part until you have carried them to a point opposite that at which you commenced the bandage; in this place deviate one of the cylinders obliquely upwards or downwards, continue on the contrary to carry the other with its band in a horizontal line until the latter meets the unwound portion of the first, which it covers and crosses, forming an acute angle; then turn and reverse obliquely the first cylinder and its oblique unwound portion upon the circular part of the second cylinder, which covers in and crosses it; afterwards making the two cylinders pursue their original direction, bring them a little above the point of departure and commence again in front the same manœuvre that has been done behind; proceed in this manner until the roller is exhausted, and fix the last convolutions, as well as one of the terminal ends, by horizontal circular turns made with the more voluminous cylinder."

There are several modes of fixing the terminal ends of roller bandages; that most commonly employed is to secure them with pins which should be always introduced with their heads looking towards the free extremity of the roller; for if the point projects in that direction, the traction of the bandage will soon cause it to stick out and catch in everything coming in contact with the part, or it may wound the hands of the patient or surgeon. If the end of the strip is narrow, its corners may be turned under so as to form an acute angle into which one pin may be introduced to confine it; if it is broader, a pin in each corner and one in the centre will be necessary. Sometimes a couple of pieces of tape are sewed to the end of the roller, which is then fastened by a double bow-knot. Bandages of the fingers are often secured by simply winding a thread around them several times and tying it. By splitting the free end of the roller to the extent of five or six inches, two tails are formed, which may be bound around

the finger and knotted. Still another way of securing a bandage is to permit a few inches of its initial extremity to remain free, and, when the roller is exhausted, tie the terminal and initial ends in a bow-knot.

SECTION II.

SPECIAL SYSTEMS OF BANDAGING.

1. Mayor's System of Bandaging.—Although simple square pieces of cloth variously folded were often employed by the ancients in bandaging, yet it remained for M. Mathias Mayor, of Lausanne, to systematize and base upon uniform and rational principles their employment. He has also added others of his own invention, and has designated them all by names grounded upon a scientific anatomical nomenclature. For instance, he commonly employs two or more anatomical terms joined together to designate each bandage; the first term pointing out the part to which its body or base should be applied, and the second that over which its extremities should be tied. Thus, the fronto-occipital triangle indicates that the base of the triangle is over the forehead, and that its ends are fastened upon the occiput; so in the fronto-cervico-labial cravat, the body of the bandage is upon the forehead; it is crossed upon the neck, and its ends are finally fastened in front of the lip; and in like manner the same plan is carried out through the whole series.

This system is ingenious and really useful under certain circumstances; but it certainly will never even partially supplant the use of the ordinary bandages, much less become generally adopted, as was intended by M. Mayor. Although the highest meed of praise has been accorded to the system by most surgeons, yet they have never failed to recognize several essential defects in it which will always restrict its employment within very narrow limits. For instance, these bandages cannot be expected to, and they do not, act efficiently in varicose veins, œdema, and some cases of hemorrhage, etc., where a uniform and continuous pressure is necessary; in fractures they are all but useless as permanent dressings, on account of their want of solidity and power to maintain the reduction of a broken bone. No one will deny this statement should he attempt the treatment of a case of oblique fracture of both bones of the leg with cravats and the hyponarthecic board. These are objections of a vital character; but there are others of a more trivial nature, among which may be mentioned the pressure of the knots by which the bandages are fastened, as well as the creases and folds which are necessarily formed by them upon parts already sensitive and tender.

On the other hand, the advantages of the system are, first, should the surgeon be so situated that more efficient bandages and apparatus cannot be obtained, as often happens during the exigencies of war both to army and naval surgeons, he will find in the handkerchief and its modifications the best possible substitute for them; secondly, the preparation and application of these bandages are so simple that, with very little instruction, any intelligent person can manage them sufficiently well to put on a provisional dressing, the timely use of which, in battle or after accidents, may determine the future fate of a pa-

tient; thirdly, the materials of the bandages—a common handkerchief or square piece of muslin, or any kind of cloth—are to be found everywhere, and always ready prepared for immediate use.

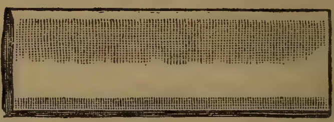
These are the prominent disadvantages and advantages of M. Mayor's handkerchief system; and although he did not design it to supplant the place of the ordinary method of bandaging at once, yet he believed that rigorously it might do so under all circumstances. The experience of other surgeons is so different, however, from that of M. Mayor, that they only employ his bandages to retain other dressings in place, to act as simple supports to parts, to serve as provisional dressings, and, lastly, to be used under circumstances of necessity where the roller and other bandages are unattainable.

M. Mayor prepares all of his bandages from one primitive form—a square piece of muslin (Fig. 83)—which is itself rarely used.

Fig. 83.

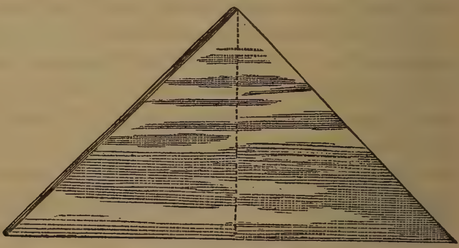
The square.

Fig. 84.



The oblong.

Fig. 85.



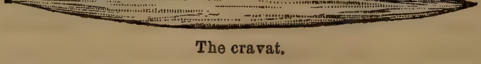
The triangle.

1. The Oblong (Fig. 84) is formed from the square by twice folding the latter in the direction of the transverse lines.

2. The Triangle (Fig. 85) results from the folding of the square in the direction of the diagonal line. The middle third of this line Mayor calls the base of the triangle, and the two lateral thirds the "extremities," or chiefs, and the angle opposite the base the "apex," or "summit."

3. The Cravat (Fig. 86) is prepared from the triangle by bringing the apex to its base, and folding it a number of times upon itself, to obtain the width and thickness we desire it to have.

Fig. 86.



The cravat.

4. The Cord (Fig. 87) is nothing but the cravat twisted upon itself.

We shall consider the special application of these bandages in Chapter VIII.

Fig. 87.

The cord.

2. M. Rigal's System of Bandaging.—M. Rigal, animated by motives similar to those which induced M. Mayor to adopt his system of handkerchief bandages, has also proposed one of his own, differing from Mayor's in two principal respects. 1st. Observing that the cravats and triangles of that author formed creases and puckers when applied to the body, which caused them to be easily displaced, he endeavored to remedy this defect by cutting the pieces of muslin into different shapes, so that they might rest smoothly upon the surface. 2d. Observing also that, their ends being firmly knotted together, the bandages were thrown from their proper position by the movements of the patient, he, to obviate this, introduced the use of gum-elastic cords to fasten them. "Which combination," says M. Rigal, "has the advantage of fastening the pieces of muslin together in such a manner that they cannot be deranged. In spite of the most varied movements of a patient, the degree of compression determined by the surgeon remains sensibly uniform; the play of the lower jaw, that of the osseous walls of the thorax, the different inclinations of the trunk, the alternate flexion and extension of the members, all these do not change at all the first arrangement established."

The same objections which have already been made to Mayor's system may be urged with still stronger reason against Rigal's; at the same time, it wants one of the peculiar advantages of the former, viz., that the materials are always at hand. Elastic threads of different sizes and lengths can, probably, be found only in cities, and any military or rural surgeon so well off in resources as to possess a supply of these will be most likely to have also at command other means superior to the bandages of Rigal. Yet the ingenuity displayed in their construction, and their fitness in certain cases, demand for them a cursory description. We have, therefore, considered their special application in Chapter VIII.

SECTION III.

THE INDICATIONS ANSWERED BY BANDAGES.

As we propose to study the bandages in anatomical order, it will be necessary to devote a few pages to the consideration of the indications which they are capable of fulfilling.

Notwithstanding the multiplicity of surgical bandages and apparatus, they may all be reduced to a few classes expressive of their mode of action and the common principles upon which they are founded. Of course such a classification cannot be rigidly adhered to, inasmuch as the same bandage may at one time belong to one class, and at another to an entirely different one; or, again, its mode of action may assimilate it to two, and even three, different classes at the same time: thus, a bandage may be at once compressive and expelling, or pro-

tective, compressive, and expelling. Indeed, there are but few bandages whose action is single; we often lay a piece of cerated muslin or other cloth upon an ulcerated leg, and secure it with a few turns of the roller, to protect the sore from external irritants while the healing process is being perfected, and we also bandage with the roller an œdematous leg, with the object of making compression only; but when both of these conditions obtain in the same leg, the bandage necessarily becomes both protective and compressive.

Yet, for perspicuity, we shall speak of the actions of these classes as if they were entirely distinct, and will refer occasionally to those special cases of disease in which their action is markedly seen; and, to further develop the subject, we shall not hesitate to allude to the action of certain surgical instruments based upon the same principle.

One of the simplest indications answered by a bandage is to protect parts from the contact of irritating agents, as when we put a shield over the eye, to ward off the glare of the light in various diseases of that organ attended with an increased sensitiveness of the retina; or when we cover delicate and granulating surfaces with a fine compress, to defend them from the action of dust, or the clothes of the person, or his bed. Here the object is simply to interpose a defence between the external agents and the surface of the body; but it happens most frequently that, besides performing these functions, the bandage serves the further purpose of a vehicle of certain medicaments, as simple cerate, the narcotic ointments, basilicon ointment, or other substances, which are spread upon its under surface for the purpose of diminishing morbid irritability, altering diseased action, stimulating indolent granulations, or of correcting the fetor of suppurating discharges.

An equally simple action is that of the *retaining bandages,* which are intended to hold dressings upon parts, or to prevent organs from again escaping from their natural cavities after having been once replaced. It is upon this principle that the different kinds of trusses, pessaries, &c., have been constructed. In fractures, also, the apparatus used in their treatment rather retains broken bones in their normal position by offering a solid resistance than by any actual force of compression. It could scarcely happen that any amount of compression brought to bear upon a fractured bone, by bandages or apparatus, would establish the normal relations of its fragments, if displaced, before the reduction has been accomplished; and in this case no such force will be required; the retaining power alone of the apparatus will be all that is needed to maintain the reduction.

In the hernial protrusions of adults, the elastic resistance of the truss-spring prevents the bowels from escaping externally, and the truss has generally to be worn the balance of the patient's life; in children, however, a well-fitting truss, with a pad bearing upon the whole length of the inguinal canal, will not only hinder the extrusion of the abdominal viscera, but often effect a radical cure by obliterating the neck of the hernial sac by the compressive force of the pad.

In prolapses of the uterus, vagina, and anus, retentive bandages have been employed with success. Those intended for the two former organs are called pessaries. Of these there are two forms: the first

consisting of a metallic instrument to be introduced into the vagina and supported *in situ* by an external bandage, as the bilboquet pessary; the second kind have no external support, but take their *point d'appui* upon the vaginal walls: the latter are now almost exclusively used in this country. Pessaries introduced into the vagina not only impede the descent of the uterus by the resistance which they offer to that organ in consequence of being supported themselves by the walls of the vagina, but at the same time they distend the upper part of this canal, which contributes largely to their retentive power.

In prolapse of the rectum, the retentive bandage consists of a perineal strap which bears upon its upper surface a pelote or knot-like projection intended to press against the anus; this strap is held in place by being buckled in front and behind to another strap passing around the loins. A better form, however, of this bandage is that where the pelote is supported at the extremity of a steel spring which takes its *point d'appui* from a pelvic strap. The principle of retention is involved in a great number of other bandages, but the above examples sufficiently illustrate it.

Suspensory bandages are used to support swollen and pendulous organs, to prevent their weight causing dragging pains, and to facilitate the circulation of blood in them. The female breast sometimes becomes greatly enlarged, either from simple inflammation or cancerous disease, and demands that it be effectually supported. We accomplish this by using one of the crossed bandages or slings of the breast, or by adhesive plaster, as seen in Fig. 88. The strips should

Fig. 88.

Mode of supporting the breast by strapping.

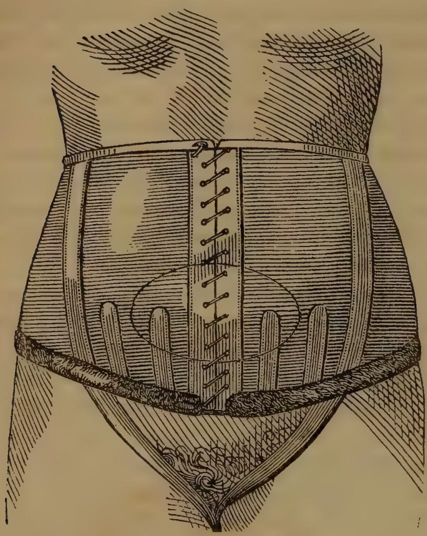
be sufficiently long to pass around the breast and shoulder, and every part of its surface except the nipple must be covered in.

The testicles suffer in a similar manner, and are maintained in an

elevated position by the well-known woven suspensory bandages of the shops.

Large and irreducible hernial protrusions also require some sort of a supporting bandage, to prevent those painful dragging sensations in the abdomen which their weight produces. These are sometimes so large that they contain most of the abdominal viscera; the stomach even may become partially extruded, and in these cases the patients are destined for the rest of their natural lives to carry these enormous tumors in a sling. In women the abdomen sometimes becomes pendulous, and requires to be efficiently supported, and for this purpose the bandage seen in Fig. 89 is well adapted. It resembles the corset usually worn by ladies, and is rendered firm and elastic by vertical strips of whalebone introduced between the outer and inner surfaces; to prevent it slipping up, which it ought not to do, however, if well made, two thigh straps are attached to the bandage.

Fig. 89.



Velpeau's bandage for supporting a pendulous abdomen.

Professor N. R. Smith, of Baltimore, has generalized the principle of suspension in the treatment of fractures, and there is no doubt but that his anterior wire splint is an improvement upon the ordinary suspensory apparatus; it is of especial value in those cases of fracture attended with wounds of the soft parts at the seat of the injury. I have used a wire splint to suspend the arm in gunshot wounds of the palm of the hand with decided advantage; it permits the arm to be placed in any position, either for the renewal of the dressing and cleansing the parts, or to facilitate the escape of pus; the suspending cord may be attached above to the ceiling or to a hoop placed over the injured limb.

Expelling bandages are such as cause any accumulated secretions to flow out from the cavities in which they may be contained by exercising compression, as is seen in cases of large phlegmonous and diffused abscesses where an expelling bandage is applied to force the secreted fluids externally and to bring the opposite walls of the cavity in contact. With the same view the proper bandaging of a suppurating stump will have an important influence upon the result of the operation, and especially when this has been effected by the flap method; for, under these circumstances, pockets and purulent collections are more apt to form than when the circular operation is performed. I

think I have seen death take place in several instances after amputation in the hospitals, during the late war, from pyemia, the result of allowing the end of the bone to be bathed in acrid pus. In various cases of fistulas and sinuses expelling bandages are also used.

Uniting bandages are employed to hold the margins of wounds together while nature effects their union. Generally, the surgeon depends upon adhesive plaster, position, pressure, and the suture, as the most efficient means to accomplish this object. Yet these may be materially assisted by the uniting bandages, such as those for horizontal and vertical wounds. In some wounds uniting bandages are indispensably necessary, as in transverse incisions upon the throat, which require the head to be flexed upon the chest. To support the suture after the operation for harelip, Mr. Dewar, of Scotland, invented a contrivance consisting of a circular elastic steel spring, reaching from the back and base of the skull forwards to each side of the fissure in the lip, and terminating there in two little pads; two vertical straps hold the spring in its place. The pads press the tissues forwards, and thus relieve the strain upon the twisted suture holding the edges of the fissure together, as seen in Fig. 90.

The object of *dividing bandages* is exactly the reverse of the preceding class, and they are much more difficult of management. In wounds attended with considerable loss of substance, as those from burns, gangrene, &c., dividing bandages are employed often with the best results in preventing, or, at least, alleviating, the contraction of the cicatrices resulting from them. Cases of this kind sometimes occur which, if abandoned to the curative effects of nature alone, would present a frightful amount of deformity and loss of function of important organs, as we see in burns of the neck, in which the contracting cicatrices sometimes draw the lower jaw down upon the chest in such a manner that the teeth are exposed, and cannot be brought in apposition, and the saliva dribbles away from the mouth involuntarily, thus destroying at once two important steps in digestion—mastication and insalivation—and necessarily impairing in a serious manner the nutrition of the patient. In the upper extremity cicatrices may bind it to the side of the chest, or destroy the functions of the fingers. From this it may be seen that it is of the greatest importance to attend to the early treatment of such cases with dividing bandages; for although plastic surgery has done much to relieve the

Fig. 90.

Dewar's apparatus for supporting the suture in harelip.

deformities following such injuries, yet we must depend upon the former for satisfactory results during the cicatrizing process, and endeavor to save the patient from a future dangerous and often unsatisfactory surgical operation. There are other means, besides these bandages, used by the surgeon to prevent the premature union of wounds. For instance, after the operation for fistula in ano, he packs lint in the incision to hinder the agglutination of its edges before the bottom of the wound has healed. He also introduces into the orifices of certain canals, after being injured, and into the punctures made in abscesses, bits of lint, elastic bougies, &c., to prevent unwished-for closure.

Of all the indications which bandages fulfil, there is, perhaps, no one as important as that of compression, considered either in the extent of its applicability or in the magnitude of the cases in which it is employed. The use of a large number of bandages and surgical instruments is based upon this principle. Moderate pressure upon parts of the human body aids their contractile power and excites their absorbents to an increased action, so that under its influence large tumors and certain organized effusions often disappear. When it is increased and continued, the nutritive functions are disturbed and atrophy is the consequence. When, again, the pressure is carried still further and becomes excessive, the parts below the point where the compression is exercised become numb, torpid, and insensible; their circulation is arrested; they grow cold, and finally mortify. In œdematous conditions of the extremities, particularly in the legs, gentle pressure, exercised by a neatly-applied reverse turn bandage, will cause the effusion to disappear, and give tone to the parts by correcting the abnormal dilatation of the capillaries and smaller blood-vessels. Of course it is necessary, for all this good to follow, that the effusion should not depend upon organic disease of interior organs essential to life.

Some surgeons are in the habit of applying a roller bandage to the entire length of a fractured limb, with a view of preventing the spasmodic action of the muscles, while others consider it either unnecessary or inefficient, believing that the splints commonly employed in such cases will exercise all the compression necessary to effect this object. As to the relative efficacy of one or the other of these plans of making compression, the question can soon be decided if we but reflect that a contracting muscle increases in diameter and diminishes in length, so that it is very apparent that any force brought counter to this diametric enlargement must diminish the extent of muscular contraction, if it does not entirely prevent it; and the roller bandage, pressing uniformly upon the whole extent of the muscular surface, as it does, and exactly in an opposite direction to the expansive force of the muscles, must be more efficient in controlling this than splints, which exercise compressive force upon a very narrow extent of surface, and do not, therefore, hinder the muscles spreading in a direction at right angles with the planes of the splints—that is, in the direction in which they are not opposed.

There does not appear to be any difference of opinion as to the advantages of applying *compressive bandages* to stumps after amputation of the limbs, for the reason that, under such circumstances, one of

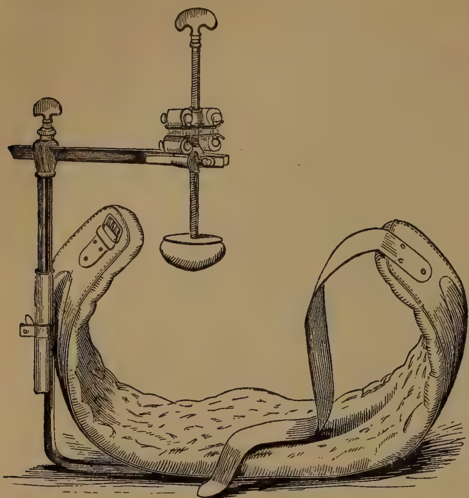
the points of attachment of the muscles being destroyed there is no obstacle to their contracting and thereby drawing up the flaps. After watching the progress of numerous amputations I am convinced that, with more skilful bandaging and shorter flaps than are commonly seen in hospitals, not only can better stumps be obtained, but, what is of more importance, the period of healing can be abridged and thereby more lives be saved. The chief error I observed during the war, in amputating, consisted in cutting the flaps too long, so that after one battle, of a large number of these operations but one patient had the flaps too short (and the flap operation was generally adopted), while a large number had them too long. Of the latter cases there was one in particular, a man whose thigh had been amputated, in which the bone had been sawn through in the upper third, and the incisions made near the lower third, so that the soft parts formed two huge flaps, an anterior and a posterior, which, in spite of the most skilful attention, kept suppurating until the patient died from sheer exhaustion. There was no doubt in this case that, had the operation been performed otherwise, and the stump properly bandaged, the patient would have made a happy recovery. I was enabled to follow up and take accurate notes of thirty-five cases of amputations; good stumps were obtained in all, and the circular operation, with flaps of the skin and cellular tissue only, was adopted in every case, care being always taken to have just enough of the soft parts to cover the end of the stump, and no more, and to bandage carefully. I saw one case, that of an officer, in which the thigh had been amputated at three different points in consequence of the retraction of the soft parts from improper bandaging.

The consideration of compression as a hemostatic means we shall defer until we come to the subject of hemorrhage.

Somewhat connected with this, however, is the subject of aneurism, in the treatment of which compression has, within the last twenty-five or thirty years, assumed great importance. A number of scores of years ago, recourse was often had to direct pressure upon aneurismal tumors, but it was not until 1760 that Vernet, a French surgeon, introduced the present practice of making compression upon the course of the artery above the tumor. After having made this important step, the treatment of this disease was far from being scientific and based upon exact observation; for the idea entertained was to bring such a compressing force upon the artery as to obliterate its cavity by pressing its walls into contact, and in doing this great pain and suffering were necessarily inflicted upon the patient, so that few had either the nerve to begin, or the endurance to sustain such a mode of treatment. The true principle was, however, at last discovered and firmly established by the labors of several eminent Dublin surgeons and others, among whom were Bellingham, Dutton, Carte, and Tafnel. They discovered that it was only necessary to make such a degree of compression as to retard the current of blood through the aneurismal tumor in order to bring about its obliteration, and with this view they invented improved instruments.

Dr. Carte's compressors are seen in the annexed wood-cuts. Fig. 91 shows an instrument for the cure of femoral and popliteal aneurism,

Fig. 91.



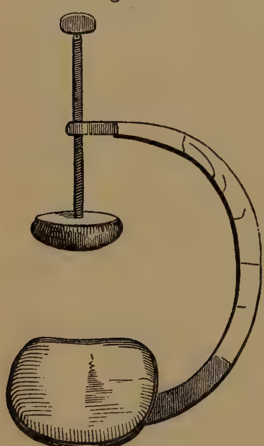
Carte's compressor for femoral and popliteal aneurism.

Fig. 92.

Carte's compressor for aneurisms of the upper extremities.

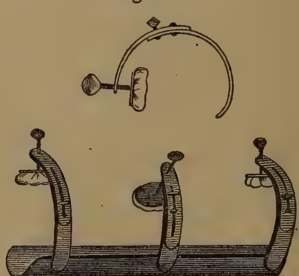
and Fig. 92 one for aneurism of the upper extremities. Fig. 93 is Hoey's clamp. With these instruments, each having but a single pad, the compression may be conveniently applied to any part of the course of an artery; but as this cannot be borne long, in conducting the treatment of a case it will be necessary to use two of the instruments at the same time to alternate the pressure upon different points. This object is, however, better attained with

Fig. 93.



Hoey's clamp.

Fig. 94.



Gibbons' modification of Charrière's compressor.

the compressor of Charrière, as modified by Dr. Gibbons, of Philadelphia, which consists, as represented in the figure (Fig. 94), of a long, broad, and concave metallic plate or gutter, which is applied to the under part of the limb, and has attached to its side three steel semicircles spanning half of the limb, and bearing at their extremities little pads, moved by screws. When the apparatus is in use one of

these pads must be screwed down upon the artery so as to interrupt the flow of blood through it, and kept there as long as the patient can bear the compression comfortably. When it causes uneasiness, the next pad is to be screwed down and the first one removed; we continue in this manner to alternate them during the treatment. In a case of ulnar aneurism I employed the following instrument, which possesses a good deal more steadiness than Charrière's:—

First, two well-tempered steel rings, of suitable diameter, were selected, and connected by two metallic bars, keeping the rings from each other at the distance of the shoulder from a point just above the olecranon. One of these bars had a width of two inches, was concave, and fitted to the outside of the limb; the other was narrower, and supported three pads at equal distances of its length, at the ends of long screws working through it; this bar was also movable, to correspond to the course of the brachial artery, and could be secured at either end by thumb-screws. This apparatus, covered with buckskin, is ready for use, and, when properly adjusted, pressure is brought to bear upon the artery by the pads being alternately screwed against it, or, what I think better, by bringing them all down lightly; for the force necessary to interrupt the flow of blood in the artery is thus distributed among the three pads, and hence a third part only of it is exercised on any one point of the skin at once.

In many cases of aneurism the patient's health is much shattered, and then the compressor may be applied night and morning, allowing him the intervening time to take exercise. In my case, the patient learned how to manage the instrument, and carried it about with him concealed in his coat sleeve.

The success attending this mode of treatment has been truly gratifying, and justifies us always in giving it a patient trial before a serious operation is undertaken. Compression for a few hours has sufficed in some cases to cause the fibrin of the blood to be deposited in the sac in such quantities as to convert it into a solid tumor, while in others several weeks are generally required to effect this good result. The way compression acts in curing aneurism is by retarding the blood in the aneurismal sac, where it deposits fibrin, layer after layer, until this is either obliterated or its cavity is reduced to a very small channel through which the blood flows.

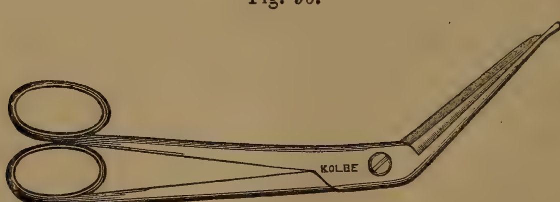
The treatment of ulcers had long remained in an unsatisfactory state until Baynton, an English surgeon, in 1797, introduced his plan of curing them by means of compression with adhesive strips. According to the statistics of Duchatelet, the average time required by the old method in an observation of 690 cases was fifty-two days; while, by compression, that period had been diminished by a half; indeed, Velpeau asserts that he has seen a large number of ulcers cured by adhesive strips in fifteen or twenty days, that had resisted all other methods. As has already been stated, Baynton used a plaster containing six drachms of resin to the pound of lead plaster; and his method of applying it was as follows (Fig. 95): "Several strips of adhesive plaster, about two inches in breadth, and sufficiently long to pass around the limb and leave an end of about four or five inches, were

taken; also several longitudinal compresses made of soft calico; and a calico roller about three inches in breadth and varying from four to six yards in length, according to the size of the limb. One of these strips is to be applied to the sound side of the limb, opposite the inferior part of the ulcer, so that the lower edge may be placed about an inch below the lower edge of the sore, and the ends drawn over the lower part of the ulcer, with as much gradual extension as the patient can conveniently bear; the other strips must be applied in the same manner, each above, and in contact with, the other, until the whole surface of the sore and the limb is covered from one inch below to two or three inches above the affected part. The whole leg should then be covered equally with the longitudinal compresses, and the roller applied around the limb from the toes to the knee with as much firmness as the patient can support. One or two circulars of the roller should be first passed around the ankle-joint, then as many round the foot, as will cover and support every part of it except the toes, and the same continued up the limb as far as the knee; the roller should be carried from the ankle upwards in *doloires,* as many reverses being made as the parts require, in order that each turn may be flat upon the limb. Should the parts be much inflamed or the suppuration very abundant, the applications are to be wetted frequently with cold spring water. The patient may take exercise, if he pleases, as this will be found to alleviate the pain and tend to accelerate the cure. The bandage ought to be daily applied soon after rising in the morning, when the parts are most free from tumefaction; and the force with which the ends of the plasters are drawn over the limb gradually increased as the parts return to their natural state of ease and sensibility." When it is necessary to remove this bandage, the blunt point of one of the blades

Fig. 95.

Baynton's plan of treating ulcers.

Fig. 96.



Bandage scissors.

of a pair of scissors, such as is represented in Fig. 96, may be passed under the strips from below upwards, upon the side opposite to that on which the ulcer is, and the bandage cut through its entire length. It ought to have been stated that, before the dressings are applied, the leg must be scrupulously shaved and cleansed, that no secretion may get between the plaster and skin to cause irritation or excoriation. The tendo-Achilles may be protected from pressure by a piece of soap plaster spread on leather, or, as suggested by Cutler, by a piece of thin sheet-lead. Should the strips produce erythema, excoriation, or inflammation, they must be discontinued for two or three days, and recourse be had to emollients until the above disagreeable accompaniments be removed. The pus coming in contact with the lead-plaster sometimes produces a black discoloration of the surface, which is, of course, entirely independent of the condition of the ulcer, and may be removed easily with a little soap and warm water, when the sore, if everything is going on well, will present a healthy red color, and granulations becoming firmer and disposed to cicatrize.

In cases of syphilis, where there is that kind of spreading ulceration which creeps under the skin of the groin in every direction, there is no better dressing than long strips of adhesive plaster; their centres being placed over the sores, the upper ends carried around the pelvis, and the lower ones around the upper part of the thigh between it and the scrotum.

Velpeau recommends compression with adhesive strips in burns. He says: "For a burn of the first degree, an application of strips supported by a bandage slightly compressing, and which may be renewed from the fourth to the eighth day, is quite sufficient. If the burn is of the second degree, that is, with phlyctenulæ and without phlegmonous tumefaction, I cause the separated cuticle to be removed, and cleanse off the exuded matters. The strips are then applied, and the cure generally takes place at the end of the second dressing, and sometimes of the first, almost always of the third; if it has not been effected by the fourth, this dressing must be abandoned. If there is engorgement and tendency to erysipelas, I commence by combating these symptoms by means of emollient cataplasms, or bleedings, and then apply the strips. If the burn is of the third degree, that is, with alteration and destruction of the surface of the cutis, we proceed as in the preceding case, and the cure is not the less certain; only it exacts from ten to twenty days. When the burn is yet deeper, when it involves the entire thickness of the dermoid tissue, the strips, not being able to prevent the necessary destruction of the parts by the elimination of the eschar, are of no use until after the removal of this latter, until, in fact, after the cleansing of the ulcer. In other respects, their application to burns is subject to the same rules as for the treatment of ulcers."

This author has also applied the same treatment to phlegmon, inflamed varicose tumors, ganglionic tumors, and scrofulous ulcers of the neck after their burrowings and loose edges have been destroyed by the acid nitrate of mercury, and to chronic pains and other affections of the joints.

In ganglionic tumors, when the patient will not submit to the operation of violently rupturing the cyst with the back of a book or other appropriate instrument, a spring compressor may be had recourse to.

M. Gariel recommends an ingenious instrument when a uniform and gentle compression is required. It consists of a little India-rubber bag furnished with a tube and stopcock. In applying it, the bag is first emptied entirely of air and bound over the part to be compressed by a few turns of a roller. Then, by blowing into the tube, the sack is distended and exerts pressure upon the parts beneath it, and the degree of compression may be varied at pleasure without disturbing the bandage.

To M. Fricke, of Hamburg, is due the credit of having first called attention to the advantages of compression with adhesive strips in orchitis and epididymitis. This dressing (Fig. 97) may be applied in the following manner: Shave the hair from the scrotum and cleanse it thoroughly, then seize the diseased testicle and force it to the bottom of the scrotum, and, taking a strip of adhesive plaster about half an inch wide and seven or eight inches long, according to the amount of swelling, apply its middle to the back part of the scrotum and above the gland, and bring its extremities forwards and cross them in front, taking care that they lie evenly upon the skin, to fix the testicle in this position. Successive strips are then applied, each overlapping half the width of its predecessor, changing their direction as you proceed towards the lower part of the scrotum that this may be covered evenly, until the whole organ is uniformly compressed; and finally the bandage is finished by passing two or three strips circularly about the tumor to confine the ends of the vertical strips. If there is much inflammatory engorgement, this dressing should be preceded by the application of a few leeches and saline purgatives. The adhesive strips should be renewed as often as they become loose by the subsidence of the swelling.

Fig. 97.

Fricke's plan of treating orchitis.

M. Récamier advised compression in the treatment of cancerous tumors. His plan was to use disks of agaric, of sufficient size to cover the diseased part, interposed between the turns of a roller bandage. The disks were of different sizes, and piled one upon another, in the shape of a truncated cone with its apex downwards, to the height of from two and a half to three inches. When the diseased surface presented ulcerated nodules, a little cone of agaric was placed upon each of them, and these were then covered by a larger piece of the same material. The outlines of a part will readily suggest in what shape the agaric should be formed. Although we cannot expect much benefit from the plan in genuine cases of cancerous disease, yet in non-malignant tumors or swellings of any sort where a uniform and elastic compression may be advisable, it will be a useful one.

Dilatation is nothing but compression exercised from within outwards, and has many useful applications in the treatment of narrowed canals and orifices.

The lachrymal canals are sometimes diminished in diameter by chronic inflammation, and require dilatation by instruments in order that the tears may pass into the nose along their natural channels instead of constantly streaming over the cheek, which they will do if these passages are occluded from any cause, constituting what is known as stillicidium, and which must be distinguished from the same condition of things arising from epiphora or an excessive secretion of tears.

In stricture of the œsophagus, dilatation is also indicated, and is effected by bougies of various kinds, gum-elastic, metallic, waxed cloth, &c. When the location of the stricture has been made out by the explorer (a small curved brass rod mounted with an ivory ball), the bougie may be introduced cautiously into the œsophagus, and passed through its narrowed part, and permitted to remain a few minutes. The operation should be performed at first once every four or five days, and as the parts become somewhat tolerant of the presence of the bougie, it may be repeated more frequently. The compression acts by stimulating the absorbents to take up the plastic matter deposited in the mucous and submucous tissues of the œsophagus.

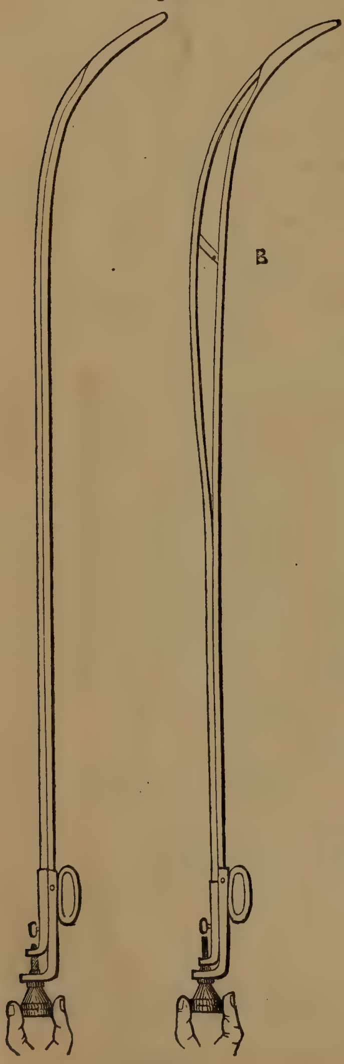
In contraction of the canal of the neck of the uterus, either when it is congenital or proceeds from disease subsequently established in that part, dilatation may be accomplished by the persevering use of bougies, as will be explained further on.

Short silver tubes, about four inches long and of different sizes, from a quarter of an inch in diameter to an inch and a half, are used to dilate a contracted vagina. One of these tubes well oiled may be passed into that canal, and retained there three or four hours at a time by a retentive bandage, such as is employed to retain the female catheter.

But it is in narrowing of the urethra, or stricture, that the greatest number of plans for exercising compression from within outwards have been suggested. The dilatation varies in its effects according to the manner in which it is employed; when gradual and gentle, the stricture yields almost imperceptibly, while a more violent and sudden compression may give rise to inflammation of the urethra, neck of the bladder, or the prostate gland. It is accomplished by means of certain instruments called bougies, which are made of silver, silvered steel, lead, tin, waxed cloth, gum elastic, gutta percha, or wax, according to the wishes or necessities of the surgeon. Some importance has been attached to the shapes of their points, some of which are cylindrical, others conical, and some, again, olive shaped or fusiform. As to the method of manipulating with these instruments, we shall defer its consideration until we come to speak of the catheterism of the male urethra. Some special instruments for making dilatation have also, at different times, been suggested. Mr. Arnott's dilator consisted of a membranous tube which he introduced into the urethra and distended with water. M. Gariel invented a dilator made of India-rubber, in the shape of an ordinary bougie, with its parietes thinned at a certain place near its point, and which expanded into a fusiform

sac when air was driven into the tube. A still more ingenious contrivance was brought forward by a French surgeon, consisting of two small steel wires continuous at their distal extremities in a rounded point, and placed side by side, and curved like an ordinary catheter. One of the proximal ends is fixed firmly to a handle and the other to a screw moving upon its axis, an arrangement which permits the surgeon to introduce the instrument as a No. 1 bougie (French scale), and subsequently to expand it by separating the wires by the action of the screw to the size of a No. 30 bougie, without removing it from the urethra. Somewhat similar to the preceding is the instrument shown in Fig. 98. In using this dilator it is introduced closed, and when the stricture is passed by simply turning the screw the blades are expanded by the little pin connecting them together at the point marked B.

Fig. 98.

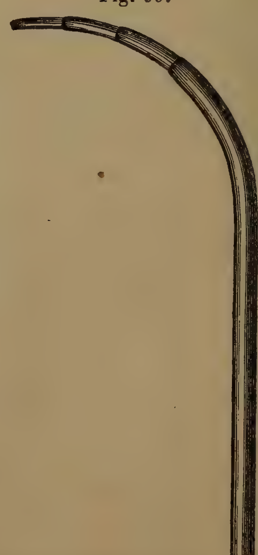


Urethral dilators.

Care should be taken to close the blades carefully before an attempt is made to withdraw the instrument, as otherwise the mucous membrane is apt to be caught between them and torn, as I have seen in two instances.

A much safer dilator, in inexperienced hands, will be found in the compound circular catheter of Dr. A. Buchanan, of Glasgow. It consists of a small round-pointed probe, over which silver tubes of different sizes

Fig. 99.



Buchanan's compound circular catheter.

are slipped one upon another, as seen in Fig. 99. In guiding this instrument along the membranous and prostatic portions of the urethra, Dr. Buchanan advises the finger to be retained in the rectum.

Mr. Sheppard, of England, employs a dilator (Fig. 100) composed of a fine catheter grooved upon one of its sides; in the groove a small wire or *traveller* slides, armed at its point with an oval metallic tip; for the dilatation of the stricture a number of tips of various sizes will be required.

Fig. 100.

Sheppard's dilator.

Mr. Wakely, of London, devised the instruments seen in the annexed wood-cuts. Fig. 102 is a very small catheter, which is used to pass the stricture; into the catheter, the slender steel rod (Fig. 101) is introduced and screwed fast, the two together forming a *directing-rod.* Over this rod are slipped a series of silver conical tubes (Fig. 103), or India-rubber tubes (Fig. 104) tipped with metallic buttons to facilitate their introduction. The tubes vary in size from one just large enough to ensheath the rod to the largest, which is equal to a No. 10 bougie.

Compression plays an important part, also, in the action of numerous orthopedic bandages and apparatus, as will be seen when we come to study that subject.

Fig. 101.

Fig. 102.

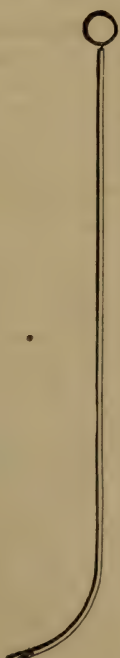
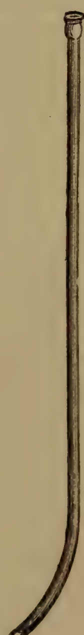


Fig. 103.

Fig. 104.



Wakely's dilators for stricture of the urethra.

In most of the instances of the use of compression which we have hitherto cited, that agency was exerted over some extent of the surface, and intended to be conservative; but there is another sort of compression which is only brought to bear upon a very restricted space, a line, and hence sometimes called *linear compression,* and is always designed to destroy the life of the parts below the point to which it is applied. Under this head fall ligatures and the écraseur.

LIGATURES.—These act in two modes, according to the way in which they are applied; if the ligature is drawn as tight as possible the moment it is put on, and the constriction is complete, the vascular supply to the parts beneath it is cut off, and they consequently soon lose their vitality, become dark colored, and fall off, leaving an ulcerating surface behind; should the ligature, however, not be drawn so tight as this, but only sufficiently to interrupt and diminish their vascular supply, the parts below then shrivel up gradually, and as the thread makes its way into the tissues, cicatrization follows close in its rear, and by the time the constricted portion is separated, the surface beneath it is nearly healed. Ligatures are made of various substances—annealed iron or silver wire, packthread, catgut, seagrass, or silk, and are applied either with the fingers or with special instruments called porte-ligatures, or knot-tighteners. Care must be taken that the ligatures be of sufficient strength to bear the amount of constriction necessary to be made, without breaking or unduly stretching, and, in applying them, to cut through the skin previously, that it may not be included in the loop, unless, as sometimes happens, the skin is diseased, or the tumor of small size, when this preliminary step will not be necessary.

There are several modes of applying a ligature; when the morbid growth is small, such as nævi materni, hemorrhoids, &c., the thread may be tied directly around its base or pedicle, and, if necessary to prevent its slipping, two hare-lip pins may be previously passed through it, at right angles to each other, having entered them through the sound skin about an eighth of an inch from the tumor and emerging at a corresponding distance upon the other side. Should the base of the tumor, however, be larger, a needle armed with a double thread may be passed through it; the threads being then separated, each of them should be tied around its corresponding pedicle. Very large tumors require to be tied in three or four portions. The best needle for this purpose is made of untempered steel with an eye near its point, which should be rather blunt, that any bloodvessels in the parts through which it passes may not be punctured by it. To divide the tumor in three portions, arm this needle with a double thread and thrust it through its base in one direction; enter it again and pass it back in the opposite direction, and finally through a third time as in the first instance, taking care that the points of transfixion be at equal distances from each other; one thread only of the first loop is cut, and both of the threads of the second loop, which will make five pairs of ends. By thrusting a needle with a double thread through the base of a tumor in one direction, then a second time in a direction at right angles to the first, and finally cutting one of the threads of the loop thus formed, we will

divide a tumor in four portions; and if two of the three pairs of ends are first knotted together, by drawing strongly upon the third pair and tying them, its whole base will be constricted.

Mr. Fergusson has improved upon this plan of constricting nævi. He prefers a common surgical needle armed with a double thread; this is thrust through the base of the tumor, and one of the threads upon that side corresponding with the needle is cut in two about three inches from the eye; the needle is then threaded with the end of that portion of the divided thread upon the opposite side of the tumor and again passed through the latter at right angles to its first course. When the threads are disengaged from the needle there will be two pairs of ends, which are to be drawn tight and tied together in two knots. In this manner, as seen in the cut (Fig. 105), two figures of 8 are formed by the threads at right angles to each other.

Fig. 105.

Mode of ligating nævus.

When the tumor is of such a form that it cannot be divided into separate portions by the above plan, the surgeon may have recourse to the method recommended by Mr. Erichsen: "A long triangular needle is threaded on the middle of a whip-cord, about three yards in length; one half of this is stained black with ink, the other half is left uncolored. The needle is inserted through a fold of the sound skin, about a quarter of an inch from one end of the tumor, and

Fig. 106.

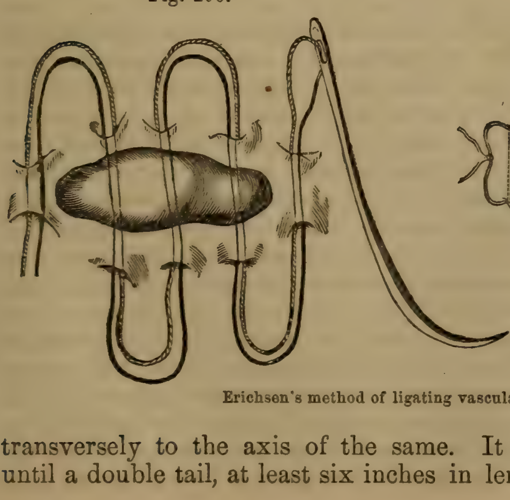


Fig. 107.

Erichsen's method of ligating vascular tumors.

transversely to the axis of the same. It is then carried through, until a double tail, at least six inches in length, is left hanging from

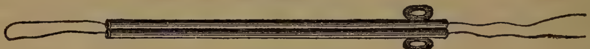
the point at which it entered; it is next carried across the base of the tumor, entering and passing out beyond its lateral limits, so as to leave, as shown in Fig. 106, a series of double loops about nine inches in length at each side. Every one of these loops should be made about three-quarters of an inch apart, including that space of the tumor, and the last loop should be brought out through a fold of healthy integument beyond the tumor. In this way we have a series of double loops, one white and the other black, on each side, as in Fig. 106. All the white loops should now be cut on one side and the black loops on the other, leaving hanging ends of thread of corresponding colors.

"The tumor may now be strangulated by drawing down and knotting firmly each pair of white threads on one side and each pair of black ones on the other. In this way the tumor is divided into segments, each of which is strangulated by a noose and a knot; by black nooses and white knots one side, by white nooses and black knots on the other, as in Fig. 107."

Subcutaneous ligature is effected by entering a curved needle armed with a thread at any point of the base of a tumor between it and the skin. Thrusting it as far as possible, shove its point through the skin, and withdraw the needle; enter its point a second time at this puncture, and pass it along again in its original course until it emerges at the first puncture, when the needle is pulled out, and the ends of the ligature tied.

When the loop of the ligature cannot be placed around the tumor conveniently, if at all, with the fingers, as happens in polypus of the nose and uterus, recourse must be had to porte-ligatures or knot-tighteners, the simplest of which is the double canula of Levret; it

Fig. 108.

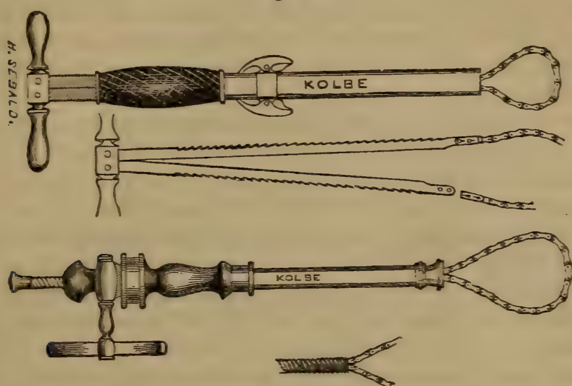


Double canula.

consists of two metallic tubes immovably connected together, and open at both ends, to one of which two little rings are soldered, one upon each side. To use the instrument, a piece of silver wire of sufficient length is passed into the tubes so as to form a loop, one of its ends being twisted around one of the rings, while, with the other end, the size of the loop is regulated until the surgeon may have satisfactorily arranged it, when that extremity must be drawn tight, and also twisted around the second ring. Graefe's knot-tightener "consists of a shaft of steel pierced at one extremity by an opening through which pass the two ends of the knot already applied; at the other extremity is a vice which, in moving to one side or the other, elevates or depresses a movable screw, to which are firmly attached the two ends of the ligature. One single turn of the vice suffices to loosen or tighten the constriction. This instrument combines great simplicity and force." The knot-tightener of Roderic, as modified by Mayor, is formed of a chaplet of small balls, representing a flexible column, through which the ligature passes by small holes in each ball.

The *écraseur lineaire* is an instrument intended to make the slow section of the tissues, somewhat in the manner of a ligature. It was recently invented by M. Chassaignac. It consists of a strong metallic tube through which, for a part of its length, a long screw works, bearing at its extremity a sort of chain loop, which projects some distance

Fig. 109.



Ecraseur.

beyond the tube; the screw is moved by a handle, and draws in the loop with a slow and steady but irresistible force; the inner margin of the chain is provided with a blunt and saw-like edge which bruises and crushes through the tissues. This action of the écraseur is one in which consists all its merits, for it is well known that arteries divided by crushing or tearing bleed very little. For the purpose of operating upon tumors of the uterus, or in localities where a straight stem could not be used with advantage, if at all, the end of the instrument may be unscrewed and a long curved beak substituted in its place. The division of the tissues must be effected slowly, to avoid hemorrhage; the time occupied in an operation will vary, according to the size and vascularity of the morbid growth, from five to twenty minutes; the handle of the instrument may be made to make one complete revolution from every two to twenty seconds. If the tumor has a very broad base, it may be ligated previous to the application of the chain of the écraseur. The after-dressings are the same as after operations in the ordinary way. The cases in which the écraseur has been used with success are, removal of the penis, testicle, tongue, neck of the uterus, and a large number of vascular and other tumors. It has even been suggested to remove limbs with it, by first dividing the bone with a special instrument, and then cutting through the soft tissues with the chain loop. But this is certainly inferior to the ordinary method of amputation, and all such efforts to render the applicability of any instrument universal, will in time bring it into discredit even in those cases in which it is really useful.

M. Maisonneuve employs a number of wire threads twisted together according to the volume and resistance of the parts to be divided,

instead of the articulated chain. The tension of the wires is regulated by a windlass similar to that of Graëfe's knot-tightener already described.

SECTION IV.

CLASSIFICATION OF BANDAGES.

The classification of bandages was for a long time involved in the greatest confusion, for the reason that their nomenclature was entirely unsystematic and without method. Some of them were called after the names of their inventors, some according to their form, whilst others bore names expressive of their use or their elegance: thus we have had the Rhomb of Hippocrates, the Tolus of Diocles, the Discrimen, the Kiaster, and the Thaïs.

Some attempts were made to found a classification upon the mode of action of the bandages; and such terms as uniting, dividing, compressing, &c., were, therefore, applied to them; but these divisions, as we have already shown, are valueless for the purposes of a nomenclature, as the same bandage may belong to three or four classes at the same time.

Gerdy proposed, in his excellent *Treatise upon Bandaging*, a classification based upon the geometric figures formed by the different bandages; and it is doubtless the best yet suggested, and has been adopted in most of the recent treatises upon bandages. This is the classification we intend to follow in this work, so modified, however, as to include all the bandages and apparatus coming within the scope we have proposed to ourselves. The following table will enable the reader to see the whole classification at a glance:—

SIMPLE BANDAGES.

- Circular Bandages.
  - Form circular turns about a part.
- Oblique Bandages.
  - Form oblique turns about a part.
- Spiral Bandages.
  - Form spiral turns called doloires.
- Figure of 8, or Crossed Bandages.
  - Form turns resembling the figure 8 or X.
- Knotted Bandages.
  - Form knots at certain parts of their course.
- Recurrent Bandages.
  - Form turns running backwards and forwards between two points.
- Handkerchief Bandages.
  - Are formed from handkerchiefs, towels, or pieces of muslin.
- Invaginated Bandages.
  - Are composed of pieces with slits in them to receive corresponding tails.

COMPOUND BANDAGES.

- T Bandages.
  - Form a figure resembling the letter T.
- Cruciform Bandages.
  - Form a figure resembling a cross.
- Sling Bandages.
  - Are formed of pieces split at their ends.
- Suspensory Bandages.
  - Form a sort of purse.

Sheath Bandages.
Form a sheath.
Laced, Buckled, and Elastic Bandages.
Are formed with buckles, lacings, and elastic cloth.

MECHANICAL BANDAGES.

Orthopraxic Bandages: Bandages for Fractures: Bandages for Dislocations.
These bandages involve, to a greater or less degree, the application of the mechanical powers.

CHAPTER VIII.

SPECIAL, OR REGIONAL BANDAGING.

SECTION I.

BANDAGES FOR THE HEAD.

SIMPLE BANDAGES.

Circular Bandages.
Of the forehead and eyes.
Crossed Bandages.
The monocle.
The binocle.
The single crossed bandage for the lower jaw.
The double crossed bandage for the lower jaw.
The crossed bandage of the head.
The crossed bandage of the head and neck.
Knotted Bandages.
The knotted bandage of the head.
Recurrent Bandages.
The recurrent bandage of the head.
Handkerchief Bandages.
The triangular bandage of the head.
The quadrilateral bandage of the head.
Invaginated Bandages.
The invaginated bandage of the lips.

COMPOUND BANDAGES.

T Bandages.
T bandage of the head and ears.
The double T bandage of the nose.
The T bandage of the head.
The double T bandage of the head.
The T bandage of the mouth.
Crucial Bandages.
The crucial bandage of the head.
Sling Bandages.
The six-tail bandage of the head.
The four-tail bandage of the chin.
The mask.
Sheath Bandages.
The sheath bandage of the nose.
The sheath bandage of the tongue.

MAYOR'S BANDAGES.

The circular cravat.
The occipito-frontal triangle.
The fronto-occipital triangle.
The fronto-oculo-occipital triangle.
The bis-oculo-occipital triangle.
The occipito-mental triangle.
The fronto-cervico-labial triangle.
The facial triangle.
The occipito-auricular triangle.

RIGAL'S BANDAGES.

The cap.
The half-cap.
The simple capeline.
The fixed capeline.
The Arabic capeline.
The shepherd's sling.
The ocular triangle.

A. Simple Bandages.

§ 1. *Circular Bandages.*

Circular bandages are applied to the different parts of the body by means of the roller, the turns of which sometimes overlap each other by half or two-thirds of their width, at others the whole width, and surround the part at right angles to its axis. They act with energy and directness upon the parts beneath, and, therefore, demand watchful attention, during their employment, that the circulation be not arrested, and mortification thereby ensue; for this reason they are not well adapted for making compression, but are used generally as a retentive means, either to secure the initial extremity of a roller or to retain dressings. The circular bandages may be applied to any part of the body possessing a nearly uniform diameter.

The Circular Bandage for the Forehead and Eyes. *Composition.*—A piece of muslin one yard long and nine inches wide, folded lengthwise in four that its lateral edges may be placed within the folds; or a roller two yards long by two inches broad.

Application.—Place the centre of the oblong compress upon the forehead, carry its extremities horizontally around the head, cross them over the occiput; then bring them forwards and fasten them to the bandage over the temples with pins.

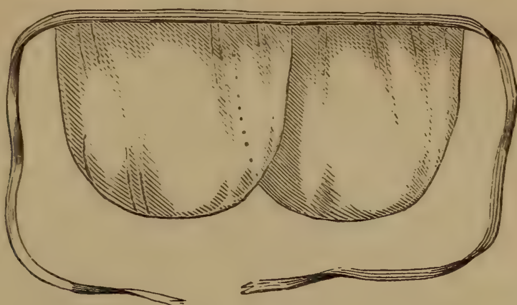
If the roller is employed, place its initial extremity upon any point of the circumference, secure it with three or four circular turns, and pin the terminal end.

By making a T-shaped incision in the middle of the compress, about half an inch from its folded margin, the upper part of the T being horizontal and the vertical one corresponding to the anterior edge of the nose, the bandage may be made to cover the eyes; the nose passing through the incision will prevent the bandage slipping down; this is called the bandeau.

Use.—To confine dressings upon the forehead, temples, and eyes, as well as to shield the latter organs from the glare of light. To

absorb any rays of light that may penetrate the folds of the bandage, a piece of some dark-colored and light material, as silk or crape, is sometimes employed in its composition. When no compression is

Fig. 110.



Bandage for the eye.

needed upon the eyes, but the object is simply to ward off the injurious action of light, a green silk shade is commonly employed; with a linen flap attached to the bandeau, and hanging over the eye, or with the arrangement seen in Fig. 110, cold water may be applied.

§ 2. *Crossed Bandages.*

THE CROSSED-BANDAGE OF ONE EYE, OR MONOCLE.—1*st Variety.*

Composition.—A single-headed roller five yards long and two inches wide.

Fig. 111.

Monocle.

Application.—Place the initial extremity upon any point of the circumference of the head and secure it by two circular turns, passing from left to right, if the object is to cover the right eye, and in the reverse direction to cover the left; when the cylinder reaches the occiput at the end of the last horizontal turn, depress it sufficiently to pass under the ear of the side affected, over its corresponding cheek to the inner canthus of the diseased eye (it is not, however, to interfere with the vision of the sound eye); then to the forehead, where a reverse is made to alter the direction of the roller to a horizontal line; follow this direction by making a circular turn to fasten the reverse upon the forehead, continue around to the occiput, depress the roller to pass again beneath the ear and over the cheek of the diseased side to the forehead, where a second reverse is made, then cover this by a horizontal turn; pursue this course, alternating circular with reverse turns three or four times, and terminate the bandage by two horizontal turns around the head. Another mode of applying the monocle is, instead of making reverse turns upon the forehead, to carry the roller over the parietal protuberance, and to alternate the circular and oblique turns thus formed. (Fig. 111.) The different turns of this bandage may be secured, with pins, to a muslin cap, which will render it much more secure.

Use.—To maintain dressings upon the eyes, and to make compression upon their globes; for the first purpose it is not so well adapted as the bandeau, and it is, besides, apt to slip.

2*d Variety of the Monocle.*

Composition.—A roller eight yards long and two inches wide, and suitable compresses.

Application.—If the right eye is to be bandaged, place a compress upon it; permit three or four feet of the initial end of the bandage to hang free from the right horizontal ramus of the lower jaw, carry the roller over the corresponding cheek and eye, over the left parietal eminence to the nape of the neck, then depress it so as to pass under the right ear and around the neck to confine the free portion of the bandage hanging below the jaw; then to the occiput and over the right ear to the forehead, where the free portion which has been brought up to this point is reflected over it, and then permitted to hang in front of the jaw again; continue around the head to the occiput, under the right ear and around the neck, when the free portion is crossed a second time, reflected over it and carried up to the level of the forehead, to be covered by the next circular turn: pursue the same course until four turns of the roller cross the eye, and then terminate the bandage by circular turns.

Use.—This form of the monocle is quite solid, and well adapted for making pressure upon the globe of the eye.

THE CROSSED BANDAGE OF BOTH EYES, OR BINOCLE.—1*st Variety; with a single-headed roller.*

Composition.—A roller eight yards long and two inches wide.

Application.—Having laid over the eyes the appropriate compresses, place the initial extremity of the bandage upon the forehead and confine it by two circular turns, arriving at the occiput; the roller being carried from right to left, pass below the left ear, and over its corresponding cheek and eye to the forehead, where a reverse is to be made to give the roller a horizontal direction around the head; arriving in front it meets the turn covering the left eye; here another reverse is made, and the direction of the roller changed, so that it now passes over the right eye under the corresponding ear to the occiput: make three or four of these oblique turns, and finish the bandage with an equal number of circulars to consolidate the whole.

Use.—To retain dressings upon the eyes; but it is inferior, for this purpose, to the simple bandeau—causing pain by its pressure, and being, besides, heavy and heating to the parts below.

2*d Variety of the Binocle; with a double-headed roller.*

Composition.—A double-headed roller eight yards long by two inches wide—one of the cylinders being somewhat larger than the other.

Application.—Place the body of the roller upon the forehead, and carry the two cylinders, one upon either side, beneath the ears to the nape of the neck, cross them, and at the same time reverse the lower turn upon the upper; then bring them forward under the ears, over the cheeks and eyes, to the forehead, where the rollers are crossed and carried over the parietal eminences to the occiput, to be again

crossed and reversed as before. The same course is to be gone over three or four times, or until the smaller roller is exhausted, and both eyes are neatly covered in. Complete the bandage by circulars with the remaining unexpended portion of the second roller, and pin its extremity. This will be found not so easily disturbed as the previous bandage, executed with a single-headed roller.

Use.—The same as the former bandage.

THE SINGLE CROSSED BANDAGE OF THE LOWER JAW. *Composition.*—A roller six yards long by two inches wide.

Application.—After having adjusted the appropriate compresses, place the initial extremity of the bandage upon the forehead, and cover it by two horizontal turns passing from left to right if the disease or injury is upon the left side, and *vice versa;* arriving at the nape of the neck, the roller is made to take a course under the ear of the sound side, under the chin and over the vertex, passing between the external angle of the eye and ear back to the chin; three vertical turns are made in this manner around the head and chin, and when the roller at the end of the third turn arrives at the side of the jaw, carry it beneath the chin and make a circular turn around the neck to the occiput, and ascend obliquely across the side of the head to the forehead to make a circular turn around this. This will bring the roller again to the nape of the neck, from which it comes beneath the ear and around the chin to the occiput, the upper margin of the turn being just below the mouth; repeat again this turn, which should overlap three-fourths of its predecessor, and continue the roller around the side of the neck under the chin up over the cheek across the vertex to the chin again, when another turn is made in a similar manner, and from its termination under the chin conduct the cylinder around the neck to make a circular turn of this part, whence it should pass obliquely across the occiput to the forehead to finish the bandage by two circular turns around the head.

In fracture of the neck of the inferior maxillary bone, it is disadvantageous to have the chin pressed upon by the circular turns, as it causes the lower fragment to be thrown forwards and upwards. So that, in such cases, all those turns of the bandage after the third vertical turn around the head and chin should be omitted; and, instead, the roller is reversed over one of the temples and the bandage finished by two circular turns around the forehead.

Use.—This modification of the bandage is employed in the treatment of fractures of the lower jaw, but in some cases, when the object is to exert compression upon the side of the neck, the former is preferable.

THE DOUBLE CROSSED BANDAGE OF THE LOWER JAW.—1*st Variety.*

Composition.—A single-headed roller seven yards long by two inches wide.

Application.—Confine the initial extremity of the bandage upon the forehead by two circular turns, passing from the nape of the neck under the right ear around the neck to the front of the left ear, conduct the roller across the top of the head to the occiput, under this to the crown of the head again where it crosses the previous turn and

passes down in front of the right ear and under the chin, in front of the left ear across the top of the head to the nape; make two more such turns, and at the end of the third one the roller is to be conducted under the chin, around the neck, under the left ear, to the occiput, from thence round the forehead to the nape, and around the neck to the occiput again. From this point make two circular turns around the front of the chin, and then pass around the neck, and return again to the place of starting, when the roller is carried across the top of the head down in front of the left ear, under the chin over the right side of the face and to the top of the head again, where it crosses the previous turn and goes on to the occiput. Go again from this point over the head, down the left side of the face, under the chin and over the right cheek, across the crown to the nape of the neck, and complete the bandage by two circular turns around the forehead.

Use.—This was formerly often employed in the treatment of fracture of the neck of the inferior maxillary bone; but the same objection can be urged against this as against the former, that is, throwing the lower fragments forward.

It answers well to make pressure upon the parotid region after suitable compresses have been placed over it.

2*d Variety; with a double-headed roller.*

Composition.—A double-headed roller eight yards long by two inches broad, with unequal cylinders.

Application.—Place the body of the bandage upon the forehead, carry the cylinders back under the ears and cross them over the nape of the neck, reversing the lower one upon the upper; then bring them forwards and cross them under the chin so that they may pass over the vertical ramus of the inferior maxillary bone to the top of the head where the turns cross, the inferior one being reversed upon the superior; from this point continue to the nape, where another cross and a reverse are to be made, and the cylinders conducted to the chin, crossed and continued over the angles of the lower jaw to the top of the head, crossed and reversed here and then carried back to the nape. This course is to be gone over three times in this manner, and the turns secured by a circular around the forehead, by that cylinder with which the reverse has been made over the back of the neck; at the latter point they will again start, go round the chin, and are crossed (the lowest turn being reversed upon the upper to prevent any wrinkling) and brought to the neck in order to make another turn similar to the preceding. This brings the two cylinders again to the occiput to cross and pass around the neck to the chin, where they are again crossed and conducted up over the cheeks to the top of the head, then crossed and brought to the nape, crossed there and passed round the neck to be crossed under the chin and run over the cheeks to the vertex, and crossed again to go to the nape. Here one of the cylinders being exhausted, the bandage is terminated by two circular turns around the forehead with the remaining roller.

Use.—This is a much firmer bandage than the one made with the single-headed roller; it is employed in the same cases.

THE CROSSED BANDAGE OF THE HEAD. *Composition.*—A single-headed roller six yards long by two inches wide.

Application.—If the right temple is to be covered in, place above the right eye the initial extremity of the bandage and confine it by two circular turns; arriving behind the right ear, reverse the roller and carry it perpendicularly beneath the chin over the left side of the face and top of the head to the place of beginning: in this manner make four or five vertical turns, or as many as may be necessary to cover in the temple. In the last turn, when the roller comes to the right ear, reverse and carry it horizontally around the head twice or three times, when the bandage is complete.

Use.—This is a very simple bandage for retaining dressings upon the temple, ear, and angle of the jaw.

THE CROSSED BANDAGE OF THE HEAD AND NECK. *Composition.*—A single-headed roller six yards long by two inches wide.

Application.—Place the initial extremity of the bandage upon the occiput, and make two circular turns around the forehead, and when the roller comes to a level with the ear, carry it obliquely over the nape and under the angle of the lower jaw; make a complete circuit of the neck, returning under the angle of the jaw of the opposite side so as to cross the previous turn over the occiput, and continue around the forehead; repeat this twice or three times, and terminate the bandage by circular turns around the head.

Use.—To retain dressings upon the back of the neck, as after the use of a seton or blister.

§ 3. *Knotted Bandages.*

THE KNOTTED BANDAGE OF THE HEAD. *Composition.*—A double-headed roller seven yards long by two inches wide, wound in two unequal heads; a pyramidally graduated compress, and a small bit of adhesive plaster.

Application.—Close the wound in the temple with the adhesive plaster and place over this the compress with its apex upon the wound. An assistant holds the compress steady, while the surgeon with a cylinder in each hand places the body of the roller over it and makes a horizontal turn to the opposite temple, when the cylinders pass each other, the lower being reversed upon the upper one, and are brought back again to the wound, over which a packer's knot is made by twisting them upon themselves so that one of the cylinders passes over the vertex and the other under the chin to the sound temple, at which point they are reversed upon each other as before. When brought to the wound another knot is made with the rollers, and then they are conducted circularly around the head. In this manner form five, six, or more knots side by side over the wound, when the small cylinder will be exhausted, and the bandage will be completed by two circular turns with the larger one.

Use.—To make compression in wounds of the temporal artery accompanied with hemorrhage. This bandage should be carefully watched, as it often exercises injurious pressure upon the margins of the lower jaw.

§ 4. *Recurrent Bandages.*

THE RECURRENT BANDAGE OF THE HEAD. (Fig. 112.)—1*st Variety; with single-headed roller.*

Composition.—A single-headed roller five yards long by two inches wide.

Application.—Confine the initial extremity at the forehead, or upon either temple, by two circular turns, just above the eyebrows, and when the roller comes to the nape reverse the bandage and hold the reverse with the left fore-finger, while the roller is carried along the median line to the forehead, where another reverse is to be made and the roller carried backwards, making a turn alongside of the former, and overlapping a third of its width. Reverse again at nape, and make another turn on the opposite side of the middle one and overlapping it; continue thus in making these recurrent turns, first on one side and then on the other, until the upper part of the head is entirely covered in, when the bandage is to be finished by two or three circulars around the forehead.

Fig. 112.

Recurrent bandage of the head.

Use.—To confine dressings upon the scalp, and to exercise a mild degree of pressure upon it where such is necessary.

This bandage is easily deranged, and not so solid as when made with the double-headed roller.

2*d Variety; with a double-headed roller.*

Composition.—A double-headed roller seven yards long by two inches wide, and wound into two unequal heads.

Application.—Place the body of the bandage upon the forehead, conduct the two cylinders backwards, above the ears, to the nape of the neck, where they are crossed, and the lower roller reversed over the upper one, and brought forward, in the median line of the head, to the forehead, where the second roller, brought horizontally around, crosses and confines it to the part. The roller that has made the vertical turn is carried again to the occiput to make another turn alongside of the first, and covering a third of its width. At this point also the horizontal roller fastens it to the occiput, and permits it to pass forwards again to form a turn upon the other side of the median one. The head is to be covered in this manner by recurrent turns, first on one side and then on the other, when, the smaller cylinder being exhausted, the large one completes the bandage by two or three circular turns. To render it more secure, the terminal end may be carried, vertically, over the head, from ear to ear, and pinned to the reverses.

Use.—The same as in the preceding case.

§ 5. *Handkerchief Bandages.*

THE TRIANGULAR BANDAGE OF THE HEAD. *Composition.*—A square piece of muslin or a handkerchief of an appropriate size folded into a triangle.

Application.—Place the base of the triangle under the occipital protuberance and let its apex hang over the face, then bring the two extremities to the forehead and cross them over the apex, when they are to be conducted to the nape and tied together, or pinned; the apex of the triangle is now to be reflected over the top of the head and pinned.

Use.—This is a very simple and easily-applied bandage for confining dressings upon the scalp.

THE QUADRILATERAL BANDAGE OF THE HEAD. *Composition.*—A piece of muslin one yard long and two feet wide, and folded lengthwise in such a manner that one side shall be three inches broader than the other.

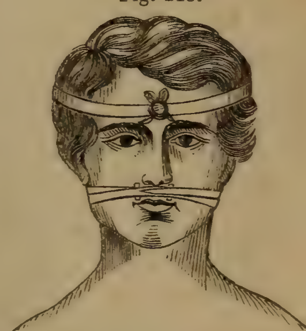
Application.—Place the middle of the bandage upon the top of the head, with the narrow side upwards, and the folded border posterior, so that the lower margin of the broader side will hang about the level of the point of the nose, and the lower margin of the other at the level of the eyebrows. The anterior angles of the narrow side are now to be drawn down and tied beneath the chin, and the other two anterior angles folded backwards over the former and tied, or pinned under the occiput. The two posterior angles of the folded border are then to be drawn down neatly and folded in between the cheeks, and that part of the bandage covering them.

Use.—This is an excellent bandage for retaining dressings upon the head, or for protecting the scalp, but it is heavy and heating.

§ 6. *Invaginated Bandages.*

THE INVAGINATED BANDAGE FOR VERTICAL WOUNDS OF THE LIPS (Fig. 113). *Composition.*—1st. A double-headed roller three yards long and three-quarters of an inch wide. 2d. Two prismatic compresses, each an inch and a half long by an inch wide, and of a thickness proportionate to the prominence of the cheek. 3d. An oblong compress a yard and a quarter long by an inch and a half wide.

Fig. 113.



The invaginated bandage for vertical wounds of the lips.

Application.—Let an assistant hold the compresses half an inch from the corners of the mouth, while the surgeon lays the centre of the oblong compress upon the top of the head and brings its two extremities under the chin. Now place the body of the roller upon the forehead, carry the two cylinders above the ears, cross them on the nape, and bring them forwards under the ears over the graduated compresses to

the upper lip; then slip one of them through a slit made in the band a few inches below the other one, when both rollers are again crossed over the nape, brought forward over the lip, and returned to the nape, at which point they are left a moment until the ends of the oblong compress have been reflected up and crossed upon the vertex and its extremities pinned over the temples, when the cylinders are again taken hold of and the bandage completed by circular turns around the forehead until they are exhausted.

Use.—To approximate the edges of vertical wounds of the lips, so as to prevent traction upon the twisted suture.

B. Compound Bandage.

§ 1. T *Bandages.*

The T bandages are those which resemble in some manner the letter of that name, and are single, when one vertical strip is attached to a horizontal one; or double, when two vertical strips are so arranged.

The T Bandage of the Head and Ears. *Composition.*—A roller three yards long and an inch and a half wide; about fourteen inches from its initial extremity the end of another roller is sewed of the same length and width, with an oval opening cut into it corresponding with the ear.

Application.—Place the initial extremity of the horizontal roller upon that part of the circumference of the head so that the vertical one will come in the line of the ear to be dressed, and confine it by a circular turn; then with the vertical band make two or three vertical turns around the vertex and chin until it is exhausted; terminate the bandage by fixing the whole by two or three circulars.

Use.—To retain dressings upon the auricular, temporal, and mastoid regions.

The Double T Bandage of the Nose (Fig. 114). *Composition.*—A strip of muslin one yard long and half an inch wide; upon the middle of this one sew two other pieces of the same width and half a yard long, at an acute angle.

Fig. 114.

Double T bandage of the nose.

Application.—That portion intervening between the two vertical strips is placed upon the upper lip beneath the nose, while the roller of the horizontal band is carried around the head, beneath the ears, and tied over the nape of the neck. The other two strips are to be carried over the top of the head, crossing each other at the root of the nose; having reached the occiput they are passed under, and reflected over, the horizontal strip, and pinned.

Use.—To retain dressings upon the nose.

The T Bandage of the Head. *Composition.*—A strip of muslin two yards long and two inches wide, to which, at about a third of its length, is attached, at right angles, another strip

one yard long and of the same width as the previous one. The horizontal band is to be rolled up in two unequal cylinders.

Application.—Place the point of junction of the two bands over the forehead with the vertical one lying along the median line of the head to the occiput, at which point the other bandelette crosses it, allowing it again to be reflected to the forehead, where it is secured by two or three circular turns.

A double T may be easily applied in the same manner by using two vertical strips instead of one.

Use.—A very light bandage for confining dressings to the scalp.

THE T BANDAGE OF THE MOUTH. · *Composition.*—A strip of muslin, four and a half yards long and an inch and a half wide, having sewed to one of its margins, about a foot and a half from its end, a second piece a foot and a half long and of the same width; at the point of junction, the vertical bandelette is to be split up an inch and a half or two inches, and a triangular piece removed from it; immediately below this an oval opening is to be made corresponding with the mouth.

Application.—The nose is thrust through the triangular opening and the oval aperture is placed over the mouth, so that the vertical band presses along the sagittal suture to the occiput, where the horizontal band coming from the mouth under the ears crosses it; it is now reflected upwards along the centre of the head, and pinned to the previous turn. The two ends of the horizontal portion are taken hold of and crossed, the inferior being reversed upon the upper one, and brought to the forehead where the bandage is completed by two circular turns.

Use.—This bandage will be found very convenient for retaining dressings upon the mouth and cheeks.

§ 2. *Crucial Bandages.*

THE CRUCIAL BANDAGE OF THE HEAD. *Composition.*—A bandelette one yard long and from one and a half to two and a half inches wide has sewed to it, about six inches from one of its ends, another bandalette two yards long and one and a half inch wide at right angles with it, forming a sort of cross, having a long and short arm, the latter being about a foot in length.

Application.—Place the juncture of the bands over the temple, upon which the dressings have been laid, with the long one horizontal; now conduct the vertical band around the head and chin, and pin them over the apex, and then complete the bandage by circular turns around the forehead with the horizontal band.

Use.—The crucial bandage of the head is well adapted by its perfect simplicity and lightness to keep dressings in place upon the temples, the parotid regions, and the ears.

§ 3. *Sling Bandages.*

The sling bandages are very simple, and often very useful and efficient; they consist of a piece of muslin with both of its extremities slit into a number of tails; the name is obtained from the resemblance they bear to the sling used by the ancients for casting stones.

THE SIX-TAILED BANDAGE OF THE HEAD (Fig. 115)—BANDAGE OF GALEN. *Composition.*—A piece of muslin a yard and a half long and twelve inches wide split at each end into three tails, the middle one being somewhat broader than the other two, leaving a central portion or body about five inches long.

Fig. 115.

The six-tailed bandage of the head.

Application.—The body of the bandage is placed upon the top of the head, and the middle tails, with their edges folded under to resemble a triangle, are tied beneath the chin. The two posterior tails are now reversed upon these and also tied beneath the chin, while the two anterior tails are conducted backwards, crossed under the occipital protuberance, and firmly knotted together on the forehead.

Use.—This bandage is very simple and well suited for retaining dressings upon any portion of the upper part of the head.

THE FOUR-TAILED BANDAGE OF THE HEAD (Fig. 116). *Composition.*—A piece of muslin a yard and a quarter long and six inches wide, split at each end into two tails to within three inches of its centre.

Fig. 116.

The four-tailed bandage of the head.

Application.—The body of this bandage may, according to the indications, be placed upon the forehead, vertex, or occiput. In the first instance, the anterior tails are tied behind the head, and the posterior under the chin; in the second, the anterior tails are knotted together over the nape of the neck, and the posterior ones in front under the chin; and in the third and last, the anterior tails are secured round the forehead and the posterior around the neck.

Use.—As seen above, this bandage will answer to hold any sort of dressings upon any portion of the upper part of the head.

THE FOUR-TAILED BANDAGE OF THE CHIN (Fig. 117). *Composition.*—1st. A piece of muslin one yard and a half long and three inches wide, split at each extremity in two tails to within one inch and a half of its centre. 2d. Compresses of suitable size.

Application.—Any compresses deemed desirable are placed upon the lower jaw and held by an assistant, while the surgeon places the body of the bandage under the chin, and conducts its anterior tails

alongside of the face, beneath the ears to the nape of the neck, crosses them here and ties them over the forehead. The posterior tails are carried vertically in front of the ears to the top of the head to be crossed there and brought beneath the chin and tied together.

Use.—The four-tailed bandage of the chin is used almost exclusively in the treatment of fracture of the lower jaw, and it answers a very good purpose as a temporary dressing in retaining the fragments in position. This is much less troublesome than the cross bandage of the chin, and is probably quite as efficient.

Fig. 117.

The four-tailed bandage of the chin.

THE MASK. *Composition.*—An oval piece of muslin large enough to cover the whole face, with suitable holes cut in it to expose the eyes, nose, and mouth, and having attached to its superior border two pieces of tape a yard long, and two similar pieces to its lower border.

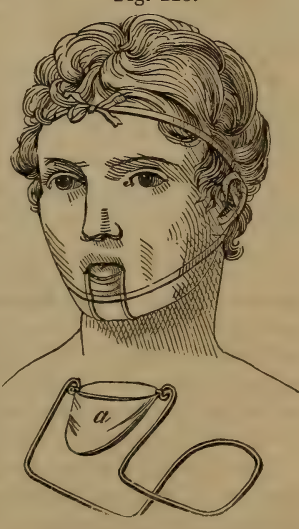
Application.—Lay the mask over the face and carry the upper tapes to the nape of the neck, cross them there, then bring them to the chin and tie them together. The inferior tapes are to be crossed in like manner over the occiput and fastened around the forehead.

Use.—To retain dressings upon the face in burns or other injuries.

§ 4. *Sheath Bandages.*

THE SHEATH BANDAGE OF THE NOSE (EPERVIER). *Composition.*—A triangular piece of muslin of sufficient size to cover the nose, with two small triangular pieces removed from its lateral angles, and the edges afterwards sewed together; this forms a sort of pocket, which will exactly lodge the nose. Now cut from its lower part two small pieces corresponding in size to the nostrils; and to the apex and to each of the lateral angles of the sheath sew a piece of tape half a yard long.

Fig. 118.



The sheath bandage of the tongue.

Application.—Place the sheath upon the nose, and conduct the two lateral tapes to the occiput, cross them, and finally tie them over the forehead; next carry the tape fixed to its apex in the course of the sagittal suture, loop it around the other tapes behind, and then reflect it forwards, and pin it to the previous turn.

Use.—To retain topical applications to the nose.

THE SHEATH BANDAGE OF THE TONGUE (Fig. 118). *Composition.*—A small pocket of muslin (*a*) of a similar shape to that of the tongue should be

prepared and fastened by its base to a piece of wire shaped like a horse-shoe, and bent twice upon itself, so that it will clasp the chin. Fasten a piece of tape a yard long to each wire as it passes in front of the chin.

Application.—The sheath is slipped over the tongue, and the wire fitted to the chin; then conduct the two tapes backwards beneath the ears to the nape of the neck, where they are crossed, and afterwards tie them together over the forehead.

Use.—This bandage was invented by Pibrac, a French surgeon, to restrain the movements of the tongue in wounds of that organ.

C. Mayor's Bandages for the Head.

We have already described the four elementary forms of all the bandages used by Mayor.

The Circular Cravat of the Head.—As the name indicates, this bandage consists of a simple cravat passing circularly around the head.

Use.—It is intended to replace the bandeau and circular bandage of the head.

The Occipito-Frontal, Fronto-Occipital, and the Bi-Parietal Triangles.—The fronto-occipital triangle consists of a triangular piece of muslin, a yard and a quarter at its base and seventeen inches from the base to the apex.

Application.—Place the base of the triangle upon the forehead above the eyebrows; draw the apex over the top of the head to the back of the neck, and carry the lateral extremities around the head, cross them over the occiput, then bring them forward and pin them over the temples. The apex is passed under the bandage behind, and turned back over the head and pinned.

The occipito-frontal and the bi-parietal triangles are used in the same manner, with this modification, that the base of the triangle is placed over the occiput in the first instance, and over one or the other temple in the second.

Use.—To retain dressings upon the head. These triangles are much simpler than the other retaining bandages of the head, as the recurrent, six-tailed, and square handkerchief, and they supply their places very often without inconvenience.

The Fronto-Oculo-Occipital Triangle. *Composition.*—A triangular piece of muslin, seventeen inches from base to apex.

Application.—Place the centre of the triangle upon the diseased eye obliquely, then carry the lateral extremities around the head, one below the ear of the diseased side and the other above the ear upon the opposite side, cross them behind, and finally tie them together over the forehead. The apex of the triangle is conducted diagonally across the top of the head, passed under the bandage upon the side, and then reflected back and pinned.

Use.—To replace the monocle.

The bis-oculo-occipital triangle may be made by disposing another triangle in the same manner upon the other side, and is used as a substitute for the binocle.

THE OCCIPITAL MENTAL TRIANGLE. *Composition.*—A triangular piece of muslin a yard and a quarter long and seventeen inches from base to apex.

Application.—Place the middle of the base of the triangle upon the top of the head, cross the lateral extremities under the chin, and pin them over the sides of the face. The apex is brought forward and pinned over either of the temples.

Use.—Employed in fractures of the jaw instead of the crossed bandages.

THE FRONTO-CERVICO-LABIAL TRIANGLE. *Composition.*—A triangular piece of muslin a yard and a quarter long and seventeen inches from its base to its summit.

Application.—Place the base of the triangle upon the forehead and conduct its lateral extremities around the head to the nape, cross them at this point and bring them forward over the lip where they may be either crossed or invaginated to regain the occiput; then fasten the extremities together. The apex of the triangle is passed beneath the bandage behind, reflected upwards, and pinned.

Use.—After the operation for hare-lip, to remove the strain upon the suture; it is intended to replace the other more complicated invaginated bandages for this purpose.

THE FACIAL TRIANGLE. *Composition.*—A piece of muslin a yard and a quarter long and seventeen inches from its base to its apex, with apertures for the nose, eyes, and mouth made into it.

Application.—Place the base above the eyebrows, conduct its lateral extremities to the occiput, cross them, and then bring them forwards again to be tied over the forehead. Draw the apex of the triangle down over the face, and carry it under the chin, and finally fasten it to that part of the bandage over the neck.

Use.—To replace the mask; it is employed in the same cases.

THE OCCIPITO AURICULAR TRIANGLE. *Composition.*—A triangular piece of muslin a yard and a quarter long and seventeen inches broad.

Application.—Place the base of the triangle upon the vertex with its apex backwards, conduct its two lateral tails downwards over one or both ears as desired, and cross them under the chin, when they are to be pinned to the bandage over the side of the face. The apex may be fastened over either temple.

Use.—To hold dressings upon the auricular, parotid and maxillary regions, and as a substitute for the knotted and T bandages of the head.

D. RIGAL'S BANDAGES FOR THE HEAD.

THE CAP is simply a triangular piece of muslin, with its base upon the top of the head, and its lateral tails fastened beneath the chin; the open part behind is closed with elastic threads passed through eyelet holes or loops. Or, again, a common skullcap split open behind and laced in this manner will answer the same purpose.

Use.—Retention of topical applications to the scalp.

THE HALF-CAP is a vertical section of a skullcap with the elastic

threads attached to its margin. It may be placed upon the forehead, occiput, or temples.

Use.—Same as the former. Both of these bandages may be advantageously replaced by the simpler ones of Mayor used for the same purposes.

THE SIMPLE CAPELINE consists of a square piece of muslin of sufficient size to cover the head when doubled.

This is folded once from side to side, and its middle portion placed upon the top of the head; the four angles at each side are brought together and fastened beneath the chin. The folds between the angles are then pinned in front or behind.

Use.—Retention of dressings to the scalp.

THE FIXED CAPELINE. *Composition.*—A square piece of muslin folded in a triangle.

Application.—Place the base of the triangle in the centre of the forehead, and conduct its two lateral tails beneath the chin, cross them there, and fasten them over the temples. The two salient folds formed between the lateral angles and the apex are laid down and pinned; lastly, the extremity reaching down the back is reflected upwards and pinned.

Use.—It serves the same purpose as the previous bandage.

THE ARABIC CAPELINE. *Composition.*—A square piece of muslin folded from side to side.

Application.—Place the body of the bandage over the forehead, with the folded side forwards, then gather up the two anterior angles and hold them until they are secured by tying the internal angles of the posterior border around the forehead, when they may be drawn under the chin and secured with pins.

THE SLING OF THE SHEPHERD. *Composition.*—1st, a skullcap of muslin; 2d, a piece of muslin six inches long by four inches broad with two of its angles perforated with eyelet holes; 3d, an elastic thread.

Application.—Place the cap upon the head, and then surround the chin by the bandelette with the eyelet holes over the angles of the lower jaw. Rest the middle of the elastic thread upon the back of the neck, bring its ends forward through the eyelet holes, and pass them up over the top of the head, where they are to be tied; secure the threads at the side by two pins.

Use.—The same as the sling of the chin.

THE OCULAR TRIANGLE. *Composition.*—1st, a square piece of muslin folded once from side to side, and each of the four angles perforated with a hole; 2d, three elastic threads; 3d, a skullcap.

Application.—Place one half of the compress obliquely over one eye (the right), pin it to the edge of the cap, then reverse the upper half upon this, so as to cover in the other eye, and leave a triangular space between the two flaps for the nose; then pin the remaining angle of the folded edge to the cap. Through the posterior holes pass an elastic thread, running behind the neck; connect the anterior holes by a similar cord, passing under the chin; then join the two elastic cords together by a third.

Use.—The same as Mayor's bandage for the eye.

SECTION II.

BANDAGES OF THE NECK AND TRUNK.

SIMPLE BANDAGES.

- CIRCULAR BANDAGES.
  - Circular of the neck.
  - Circular of the chest and abdomen.
- OBLIQUE BANDAGES.
  - Oblique bandages of neck and axilla.
- SPIRAL BANDAGES.
  - Spiral bandages of the body.
- CROSSED BANDAGES.
  - Posterior figure of 8 of the head and axillas.
  - Anterior figure of 8 of the head and axillas.
  - Figure of 8 of the head and one axilla.
  - Figure of 8 of the neck and axilla.
  - The spica or figure of 8 of the shoulder and opposite axilla.
  - The anterior figure of 8 of the shoulders.
  - The posterior figure of 8 of the shoulders.
  - The crossed bandage of the chest.
  - The crossed bandage of one breast.
  - The crossed bandage of both breasts.
  - The crossed bandage of one groin.
  - The crossed bandage of both groins.

COMPOUND BANDAGES.

- T BANDAGES.
  - The double T of the chest and abdomen.
  - The anterior double T of the head and chest.
  - The posterior double T of the head and chest.
  - The double T of the pelvis.
  - The T bandage of the groin.
- THE CROSSED BANDAGE OF THE TRUNK.
- SLING BANDAGES.
  - The sling bandage of the shoulder.
  - The sling bandage of the breast.
  - The sling bandage of the hip.
- SUSPENSORY BANDAGES.
  - The suspensory of the breast.
  - The suspensory of the testicle.
- SHEATH BANDAGES.
  - The sheath of the penis.

MAYOR'S BANDAGES FOR THE NECK AND TRUNK.

- The cravat of the neck.
- The occipito-thoracic triangle.
- The fronto-thoracic triangle.
- The parieto-axillary triangle.
- The thoracico-scapular triangle.
- The simple bis-axillary cravat.
- The compound bis-axillary cravat.
- The simple dorso-bis-axillary cravat.
- The compound dorso-bis-axillary cravat.
- The cravat, triangle, and squares.
- The triangular cap of the breast.
- The cervico-thoracic cravat.
- The cervico-dorso-sternal cravat.
- The sacro-pubic triangle.
- The intercrural cravat.
- The cruro-pelvic triangle.

The cruro-pelvic cravat.
The sacro-bi-crural cravats.
The sacro-lumbar triangle.
The coxo-pelvic triangle.

RIGAL'S BANDAGES FOR THE NECK AND TRUNK.

The cervico-axillary cravat.
The lateral thoracic bandage.
The sternal triangle.
The dorsal triangle.
The thoracico-abdominal bandage.
The girdle.

A. Simple Bandages.

§ 1. *Circular Bandages.*

Circular Bandage of the Neck. *Composition.*—A roller a yard and a quarter long and an inch and a half or two inches wide.

Application.—Confine the initial extremity upon the neck by a circular turn, and finish the bandage by exhausting the roller.

Use.—An extremely simple mode of keeping dressings upon the neck. Care should be taken not to constrict the neck in such a manner as to interrupt the circulation in the bloodvessels of that part or interfere with the respiration.

Circular Bandage of the Body. *Composition.*—A piece of muslin of more than sufficient length to go around the body, and from a foot to a foot and a half wide. If the bandage is to be applied to the chest (circular bandage of the chest) place the body of the piece of muslin upon the back and bring its ends to the front, then overlap and pin them.

On the contrary, if the abdomen is to be bandaged, place the middle portion of it upon the loins (circular bandage of the abdomen). In order to prevent these bandages slipping up or down, two small strips of muslin are sometimes attached to their upper and lower edges, passing over the shoulder and under the perineum.

An abdominal bandage may be prepared which will retain its place without the aid of scapular or perineal strips. It consists of a piece of muslin with gores made in its lower margin and fitting over the hips, the bandage being prevented from wrinkling by four pieces of very flexible whalebone inserted vertically at the sides and front. Its anterior edges are perforated with eyelet holes to receive the lacing cord.

Other more complicated abdominal supporters are often recommended, but this one will answer every purpose, and may be made in a few minutes in any household.

Use.—The circular bandage of the chest is used to insure immobility of the walls of the chest in fractures of the bones composing it. The abdominal bandage serves the purpose of supporting the walls of the abdomen in pregnancy, after confinement, and the operation of paracentesis.

§ 2. *Oblique Bandages.*

THE OBLIQUE BANDAGE OF THE NECK AND AXILLA.—1*st Variety.*

Composition.—A roller bandage six yards long and two inches wide.

Application.—Place the initial extremity of the bandage upon the shoulder of the healthy side, and confine it by a circular turn passing across the chest under the axilla and across the back to the point of starting. The bandage is finished when the roller shall have been exhausted by these turns.

Use.—As a retentive bandage for the axilla, but it is badly adapted for this purpose, for the reason that the turns under the arm become corded, and they are apt to gall a tender surface.

2*d Variety; the oblique bandage of the neck and axilla, for venesection at the external jugular vein.*

Composition.—1st. A bandelette four yards long by two inches wide. 2d. A prismatically graduated compress about three inches long by two inches broad at its base.

Application.—Place the compress over the external jugular vein just above the clavicle, and over this place that portion of the body of the bandelette about two feet from its extremity, the shorter end hanging obliquely across the chest; carry the longer one over the shoulder corresponding to the vein from which blood is to be taken, across the back to the opposite axilla, under which it passes to cross the compress and shoulder to return again to the axilla. Now draw the two extremities of the bandage moderately tight, until the external jugular bulges sufficiently to be opened, and then tie them together.

Use.—Only in venesection at the neck.

§ 3. *Spiral Bandages.*

SPIRAL BANDAGE OF THE BODY—SPIRAL BANDAGE OF THE THORAX. *Composition.*—A roller ten yards long and two inches wide.

Application.—Let a yard and a half of the free extremity of the bandage hang down from the right shoulder in front of the abdomen, then carry the roller across the back under the left axilla, in front of the chest so as to make a circular turn of the thorax, and continue in this manner descending, each turn overlapping a third or half of its predecessor, towards the abdomen, until the bandage is exhausted; pin its terminal extremity. The free portion is now to be reflected over the left shoulder, and fastened behind with pins.

Use.—To retain dressings upon the chest, and to make compression in fracture of the ribs. In the latter case suitable compresses are to be employed, of which two are to be placed upon either side of the line of fracture if the fragments form a salient angle, and at the extremities of the rib if it is re-entrant.

§ 4. *Figure of* 8 *Bandages.*

THE POSTERIOR FIGURE OF 8 OF THE HEAD AND AXILLAS. *Composition.*—A roller ten yards long and two and a half inches wide.

Application.—Confine the initial extremity of the bandage by two circular turns at any point of the circumference of the head, which is

drawn backwards as far as desired; when the roller comes to the mastoid process of the left side, conduct it obliquely across the neck and right scapula, and under the corresponding axilla, in front of which you must ascend to the point of departure; from whence the roller passes around the forehead to the mastoid process of the opposite side, across the neck to the left axilla, under and in front of this to return to the neighborhood of the right ear, when the head is to be surrounded by a circular turn to confine the first two oblique turns. Repeat this course again, and terminate the bandage by a circular turn around the forehead.

Use.—This is called the anterior dividing bandage, and is used to retain the head in a position of more or less forced extension in burns of the front of the neck, when we fear distortion from excessive contraction of the cicatrix drawing the head forward. The bandage is easily deranged, and not so advantageous for this purpose as others, to be described further on.

It should be mentioned here, that in all of those bandages which have their turns passing under the axilla, the sharp margins of the latter, formed by the projection of the pectoralis major and the latissimus dorsi, should be protected by suitable compresses.

THE ANTERIOR FIGURE OF 8 OF THE HEAD AND AXILLAS.—This bandage is applied in the same manner as the preceding, only reversing it; the crosses, which are upon the back of the neck in the former, are in front in the latter.

Use.—The posterior dividing bandage is used for similar purposes as the preceding, when the injury is situated upon the nape of the neck, but it is exceedingly annoying to the patient by the crossings of its turns upon his face, at the same time being less effective than other dividing bandages to be mentioned presently.

THE FIGURE OF 8 OF THE HEAD AND AXILLA. *Composition.*—A roller seven yards long by an inch and a half wide.

Application.—Incline the head at the desired angle upon one or the other side, and confine the initial extremity of the bandage upon the head by two circular turns; then pass from the occiput in front of the shoulder to which the head leans, under the axilla, up over its posterior surface, to a point just above the nearest eyebrow; make a reverse here, in order to pass horizontally around to the nape of the neck, thence conduct the roller in front of and under the axilla to the forehead, where another reverse is made over the previous one; repeat these turns three or four times, and terminate the bandage by circular turns around the upper part of the arm. Secure the reverses with pins.

Use.—To bind the head to one side in order to counteract the contraction of a cicatrix upon the opposite side of the neck, acting thus as a right or left dividing bandage of the neck, according as the head is drawn to the left or right side; also as a uniting bandage for the side of the neck to which the head is inclined.

THE FIGURE OF 8 OF THE NECK AND AXILLA. *Composition.*—A roller five yards long and two inches wide.

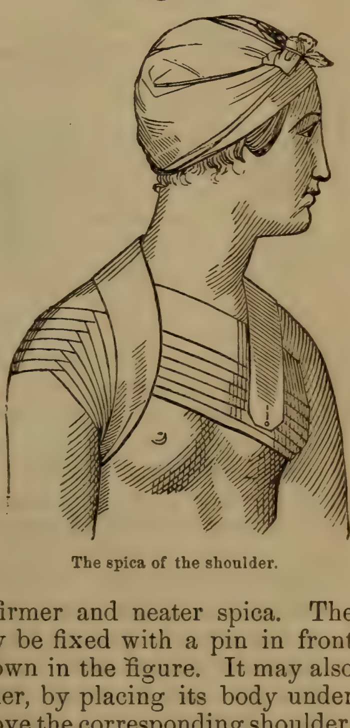
Application.—Place the initial end of the bandage upon the neck

and secure it by two circular turns, and then, if the object is to cover in the right axilla, conduct the bandage in front of the neck, from left to right, over the right shoulder, to the posterior part of the axilla, under which it passes to ascend in front of the same shoulder to the nape of the neck; from this point pass around the neck and go over the same course three times, and terminate by two circular turns around the upper part of the arm. When the bandage is applied upon the left side, the roller must pass from right to left. It may also be executed with a double-headed roller, in which case the body is placed under the axilla, one of the cylinders is conducted in front and the other behind the shoulder to its top, where a cross is made; then the former passes behind the neck and the latter in front of it, to meet each other in opposite directions upon its opposite side. The rollers are to be again crossed over the shoulder, conducted beneath the axilla, and the same process repeated three or four times.

Use.—To support dressings upon the shoulder and in the axilla. The bandage is not very firm, and its turns cord in the axilla, and therefore it is unsuitable as a retentive means of topical applications in this region.

THE SPICA OR FIGURE OF 8 OF THE SHOULDER AND OPPOSITE AXILLA. (Fig. 119.) *Composition.*—A roller eight yards long and two inches wide.

Fig. 119.



The spica of the shoulder.

Application.—Confine the initial extremity to the upper part of the arm by two circular turns, and when the roller arrives at the posterior margin of the axilla, conduct it behind the shoulder, over the root of the neck, across the front of the chest to pass under the opposite axilla, and obliquely across the back to the top of the shoulder again, where it crosses the previous turn. From this point the cylinder goes under the axilla, and over the same course as before, until five or six turns are made, or as many as will cover the shoulder from the root of the neck to the point of the acromion. In this manner one cross follows another from above downwards, when the spica is said to be *descending;* when they proceed in the reverse direction, the spica is said to be *ascending;* the former making a firmer and neater spica. The terminal extremity of the bandage may be fixed with a pin in front or behind, or secured in the manner shown in the figure. It may also be executed with a double-headed roller, by placing its body under the axilla, crossing the two cylinders above the corresponding shoulder, and conducting them around the chest in opposite directions to the axilla of the opposite side, where they pass each other to be brought

back to and crossed over the injured shoulder, and then passed under the corresponding axilla. Repeat these turns until the bandage is exhausted.

Use.—To retain dressings or apparatus upon the shoulder, clavicle, and scapular region, as well as to make pressure upon the former.

THE ANTERIOR FIGURE OF 8 OF THE SHOULDERS. *Composition.*—A roller five yards long by two inches wide.

Application.—Direct an assistant to draw the shoulders strongly forward, and to retain them in this position during the application of the bandage. Confine the initial extremity of the bandage to the upper part of the right arm, passing from before backwards, ascend behind the right shoulder and cross over it and the front of the chest obliquely to the left axilla, pass up the posterior surface of the shoulder to its top, when the roller takes a course obliquely across the chest to the right axilla, the two turns making a figure X over the sternum. Repeat these turns in this manner three or four times and pin the terminal end of the bandage to them either in front or behind.

Fig. 120.

The anterior figure of 8 of the shoulders.

Use.—To prevent the formation of vicious cicatrices upon the back of the shoulder; to approximate the lips of wounds upon the anterior and upper parts of the chest; in fracture of the upper part of the sternum; and to maintain the reduction of the inner extremity of the clavicle dislocated forwards.

THE POSTERIOR FIGURE OF 8 OF THE SHOULDERS. *Composition.*—A roller five yards long by two inches wide.

Application.—The patient being seated upon a chair, the shoulders are well drawn back. Confine the initial extremity of the bandage to the upper part of the right arm, passing from behind forwards in the axilla, ascend in front of the right shoulder to the root of the neck, then cross the back of the chest obliquely to the left axilla under it and in front of the left shoulder, over its top, and thence diagonally across the back, the turns crossing each other, to the right axilla. Repeat this course three times and terminate the bandage by pinning the terminal end behind.

THE CROSSED BANDAGE OF THE CHEST. *Composition.*—A roller eight yards long and two inches wide.

Application.—Place the initial extremity of the bandage under the right axilla and conduct the roller obliquely upwards across the chest

to the top of the left shoulder; pass behind this, and beneath the axilla up in front of the chest to the root of the neck; then go obliquely across the back of the thorax to the right axilla; under this to the front, and upwards to the right side of the neck. From this point the roller takes its course obliquely downwards across the back of the chest to the left axilla, under which it passes to the front to cross the chest to the right shoulder, behind which it passes, and under the right axilla; thence upwards to the top of the left shoulder behind which the cylinder courses under the axilla to the front, and upwards to the root of the neck, around the posterior surface of this part to the right shoulder and axilla, under which it passes to gain the top of the same shoulder, and to cross the chest obliquely to the left axilla; from this point the bandage is completed by three or four circular turns around the lower portion of the chest.

A firmer quadriga may be made with a double-headed roller wound in two unequal cylinders. Place its body under the right axilla, conduct the two cylinders to the top of the right shoulder, where they are crossed, and continued to the left axilla, one in front the other behind the chest, under which they are again crossed, and carried to the top of the left shoulder to be crossed and finally brought to the right axilla. Repeat this course two or three times, and terminate the bandage as in the former instance.

Use.—As a retentive bandage in fracture of the ribs, upper part of the sternum, and dorsal vertebræ. It is rarely ever used, however, its place having been usurped by the spiral or circular bandage of the chest. and by long, broad strips of adhesive plaster laid over the chest circularly.

THE CROSSED BANDAGE OF ONE BREAST. *Composition.*—A roller eight yards long by two inches wide.

Application.—Confine the initial extremity of the roller under the diseased mamma, the left, for instance, by two circular turns, passing from left to right; at the end of the third turn direct the roller obliquely between the two breasts to the middle of the top of the right shoulder, descend across the back to the left side, and make a circular turn of the chest to hold the oblique one, then ascend to the right shoulder as before. Make a sufficient number of turns in this manner to cover in and support the mamma, and terminate the bandage by a circular turn around the chest above or below that organ according to the circumstances of the case.

Use.—To support and retain topical applications to the mamma, and at the same time make some degree of compression.

This bandage may be advantageously supplanted by the single sling of the breast, to be described hereafter, and especially when it is necessary to renew the dressings frequently.

THE CROSSED BANDAGE OF BOTH BREASTS. *Composition.*—A roller bandage twelve yards long by two inches wide.

Application.—Confine the initial extremity of the roller upon the lower part of the chest by three circular turns passing from right to left; when the roller in the third turn arrives at the right side conduct it obliquely upwards between the breasts to the middle of the top of

the left shoulder, thence down the back to the point of departure at the right side, then continue it transversely around the thorax to the left side, obliquely upwards over the back to the right shoulder; down in front of the chest under the left mamma, transversely across the body, around the right side and upwards again between the breasts to the left shoulder; cross the back to the right side, and make a horizontal turn under the chest to the right shoulder, descend under the left mamma and transversely around the posterior surface to the right side. In this manner make in all four or five crosses upon the sternum, or until both breasts are covered in, and terminate the bandage by circular turns around the body.

A double-headed roller of the same length as the preceding, and wound in two unequal cylinders, may also be employed in making the double cross of both breasts.

Place the body of the roller upon the middle of the lower and posterior part of the thorax, bring the two cylinders forward and cross them between the two mammæ, when one of them is to be carried over the right shoulder and the other over the left, and crossed on the back; repeat this course a second time; then, holding one of the cylinders at the back, conduct the longer one around the chest circularly to confine the two oblique turns. Bring both of the cylinders forward again, one passing under each breast. Cross them over the sternum, and conduct them one over either shoulder, when another circular turn is to be made as before. Alternate these oblique and circular turns until the bandage is exhausted, and secure the terminal end with pins.

Use.—Employed in the similar cases as the crossed bandage of one breast, when both mammæ are diseased.

The Crossed Bandage of the Groin (Spica). *Composition.*—A roller seven yards long and two inches wide.

Application.—Place the initial extremity of the bandage upon the abdomen, just above the umbilicus, and confine it by two or three circular turns, passing from left to right if the right groin is to be covered in, and the reverse if the left. When the roller arrives at the right flank, carry it obliquely across the upper part of the groin to the perineum, going between the right thigh and scrotum; then around the gluteal muscles to the point just above the right superior spinous process, where the roller is conducted across the abdomen to the left side, and around the loins to the right side again, when the same process is gone over again seven or eight times, or until the groin is covered in; each turn covering half of its predecessor and placed below it; terminate the bandage by circular turns around the abdomen. Made in this manner, the spica is said to be "descending;" and on the contrary, when the turns overlap each other from below upwards, it is "ascending." A double-headed roller may also be used by placing its body upon the loins, conducting the two cylinders forwards, one around either side, crossing them over the groin, and afterwards behind the upper part of the thigh, when they are brought forwards again and crossed. Continue this process until the bandage is exhausted.

Use.—To sustain dressings upon the groin, and also to make pres-

sure in cases of abscess, sinus, and hernial protrusions, the proper compresses having been previously applied over the parts.

THE DOUBLE SPICA, OR CROSSED BANDAGE OF BOTH GROINS. *Composition.*—A roller twelve yards long and two inches wide.

Application.—Place the initial extremity in the same position as for the single spica, and retain it by three circular turns around the abdomen, passing from right to left. When the roller comes to the right side, conduct it obliquely across the abdomen just above the penis to the outer side of the left thigh below the trochanter; pass over the back of the limb to its inner side, and ascend upwards towards the left anterior spinous process, crossing the previous turn below the groin. From this point, carry the cylinders to the corresponding process upon the right side, across the loins, down in front of the right groin, around the upper part of the right thigh, and in front to cross the previous turn, and ascend to the left flank around the back to the right side, the point at which the first oblique turn began. Go over this course three or four times, making an ascending spica, and terminate by circular turns around the abdomen.

The same bandage may be executed with a double-headed roller: place its body upon the loins and make two circular turns around the abdomen, then bring the cylinders forwards, cross them over the pubis, conducting one of them around the outer surface of the right thigh and the other around the left, to the front, passing between the scrotum and thighs; then cross the previous turns over the groins, when the cylinders should be led to the point of starting upon the loins. The same manœuvre is to be repeated as often as necessary to cover both groins.

Use.—In similar cases as the single spica, when the disease is seated upon both groins.

B. COMPOUND BANDAGES.

§ 1. *The Double T of the Body.*

THE DOUBLE T OF THE CHEST. *Composition.*—A piece of muslin the depth of the chest, and of sufficient length to entirely surround the body and overlap three or four inches, and two pieces of muslin, each two feet long and two inches wide.

Application.—Place the body of the bandage upon the back of the thorax, bring its two ends forwards, overlap them, and pin. To prevent the bandage slipping down, the two bandelettes, passing one over each shoulder, are pinned to its superior margin.

THE DOUBLE T OF THE ABDOMEN. *Composition.*—The same as the preceding bandage.

Application.—The body of the bandage is placed over the loins, and its ends brought forwards over the abdomen, and pinned. The two straps are conducted beneath the perineum and fastened to the lower margin of the bandage.

Use.—The double T of the chest is used to retain dressings upon the upper portion of the body, and to restrain the movements of the chest in fracture of the ribs.

The double T of the abdomen is employed to maintain topical remedies upon the lower portion of the body, and also to make compression, as after the operation of paracentesis abdominis and accouchement, and to prevent the displacement of the bowels in eventration.

THE ANTERIOR DOUBLE T OF THE HEAD AND CHEST. *Composition.*—1st. A double T bandage of the chest. 2d. Four bandelettes, one four yards long and two inches wide, to the superior border of which is sewed a second bandelette two feet long and of the same width, and to its lower border the ends of the other two bandelettes, each a foot and a half long and one inch wide, one fifteen and the other twenty inches from the initial extremity; the superior bandelette being between them.

Application.—First fix the bandage to the thorax, then place the initial extremity of the long arm of the bandelette over the right eyebrow and confine it by a circular turn, bringing the superior bandelette over the forehead in the median line. The latter is now to be conducted to the occiput, looped around the circular turn, and brought forward again and pinned over the top of the head, when other circular turns are made until the band is exhausted. Now flex the head to the required angle, and hold it in that position by pinning the two strips hanging down from either side of the head upon the chest bandage.

Use.—Used as a uniting bandage of wounds of the anterior portion of the neck, and as a dividing bandage in burns upon the posterior surface of the same part.

THE POSTERIOR DOUBLE T OF THE HEAD AND CHEST.—This bandage is applied in the same manner except that the two vertical pieces of muslin should descend the back.

Use.—To draw the head backwards, and is used under exactly the reverse circumstances of the anterior double T.

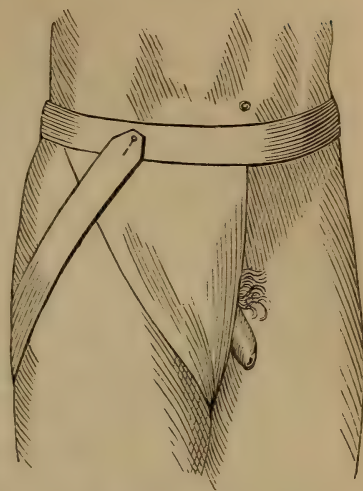
THE DOUBLE T OF THE PELVIS. *Composition.*—An oblong piece of muslin, folded upon itself, about four inches wide, and sufficiently long to more than complete the circuit of the pelvis by three or four inches. To the middle of its inferior margin sew two strips of muslin, one inch wide and a yard long, at a distance of one inch and a half apart.

Application.—Place the body of the bandage over the sacrum so that the two strips may hang down behind opposite the scrotum, bring its lateral ends forward, overlap, and pin them securely; then conduct the two bandelettes between the legs, one upon each side of the scrotum, and pin them to the bandage in front. Where only one strip of muslin is employed, the single T is formed.

Use.—To maintain dressings upon the sacrum, anus, perineum, and vulva.

THE T BANDAGE OF THE GROIN (Fig. 121). *Composition.*—A triangular piece of muslin of sufficient size to cover in the groin and to extend to the middle of the thigh. To one angle of its base sew the end of a strip of muslin two and a half yards long and an inch and a half wide; to the other a strip of the same width and four yards long. To the apex

Fig. 121.



The T bandage of the groin.

of the triangle is attached the middle of a third strip, a yard long and of the same width as the preceding.

Application.—Place the base of the triangle just above Poupart's ligament with that angle of the base to which the long bandelette is attached looking towards the healthy side, for instance, the left; then carry the band of the outer angle around the left hip, across the small of the back, and in front of the lower portion of the abdomen to the point of departure; let it be held there until the band connected to the inner angle shall have been carried around the right hip obliquely across the sacrum to the outer part of the left thigh, around which it passes in front upon the triangle to the right flank, and across the back to the left flank, when the two ends are to be tied together. The apex of the triangle is fixed by a circular turn around the middle of the thigh.

Use.—To hold dressings upon the groin, but it is inefficient when the patient moves around.

§ 2. *The Crossed Bandage of the Trunk.*

This bandage is very similar to the T bandage of the trunk, and is composed of a broad piece of muslin to go around the chest and overlap three inches, with two straps attached to its superior border which pass over the shoulders, and two to its inferior margin passing under the perineum. It may be similarly applied to the abdomen.

Use.—The cross bandage of the trunk is used under similar circumstances as the double T bandages of the same part.

§ 3. *Sling Bandages.*

THE SLING BANDAGE OF THE SHOULDER. *Composition.*—A piece of muslin eight or ten inches wide and two yards and half long, split from each end into two tails.

Application.—Place the body of the bandage over the shoulder, conduct its superior tails, one in front and the other behind the chest, to the opposite axilla, cross them here, and bring them back to the shoulder and tie them; the inferior ones are exhausted by circular turns around the upper part of the arm.

Use.—This bandage is used to support dressings upon the shoulder; but it is not very firm.

THE SLING BANDAGE OF THE BREAST. *Composition.*—A piece of muslin eight or twelve inches square, having sewed to one of its sides a muslin strip three yards long and two inches wide, and to each of its opposite angles a narrow strip an inch and a half wide and a yard long.

Application.—Place the square piece of muslin over the breast, with the broad band horizontal, the two ends of which latter are now to be carried around the chest beneath the mammæ, crossed upon the back, brought forward and pinned in front. The two narrow strips are passed around the neck, one upon either side, to its back part over which they are tied in a bow knot.

Use.—To support the breast, and to sustain poultices or other dressings in place.

THE SLING BANDAGE OF THE HIP. *Composition.*—A piece of muslin two yards and a half long and eight or ten inches wide, split at each end in two parts.

Application.—Place the body of the bandage over the hip, conduct its superior extremities around the loins, cross them there, and finally tie them on the same side on which the bandage is. The two extremities are to be fastened by a knot around the upper part of the thigh.

Use.—To retain dressings over the hip.

§ 4. *Suspensory Bandages.*

THE SUSPENSORY BANDAGE OF THE BREAST. *Composition.* — A piece of muslin about eight inches wide and nine inches long; fold it upon itself lengthwise and remove with the scissors the angles adjoining the folded border, and sew the edges thus made together. To the two upper angles attach two bandelettes one inch wide and a foot and a half long, and to the inferior angles two or more of similar width but a yard and a quarter long.

Application.—Place this sort of cap-like piece of muslin over the diseased mamma, carry the superior bandelettes around the neck, and tie them behind it, and the inferior ones around the chest; cross them over the posterior surface of the chest, and finally bring the ends forward again to be tied or pinned in front.

Use.—To support the mamma when large and pendulous, and to retain topical dressings upon the part.

THE SUSPENSORY BANDAGE OF THE SCROTUM. *Composition.*—A piece of muslin (Fig. 122), whose size will vary according to the volume of the testicles, must be taken; for ordinary use, six inches wide and eight inches long will answer; fold it in the direction of its length, and with the scissors, remove the angles (*a d* and *b a*) in the direction of the dotted lines, sew the edges together along the line (*a*, *b*), and also sew to the angles (*b*) the extremities of two pieces of muslin one inch wide by two feet long, each having a button-hole worked in the free end. Attach the two borders (*c*, *d*) to

Fig. 122.

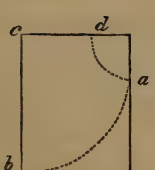
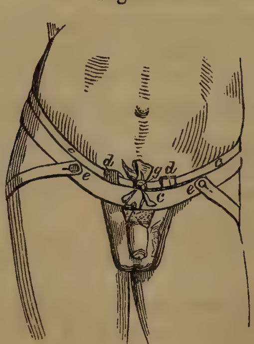


Fig. 123.

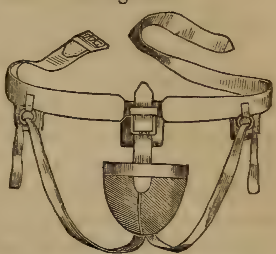


The suspensory bandage of the scrotum.

the middle of a muslin strip doubled upon itself and sewed together to make a sort of belt, an inch wide and two yards and a half long, with a button near each free extremity.

Application.— Introduce the scrotum, covered with its dressings, into the suspensory, with the penis projecting out of the aperture in front, carry the horizontal bands around the pelvis, cross them behind, and finally bring them to the front, and fasten the extremities over the pubis with a pin or button. The two other strips are conducted behind, around the upper portion of the thigh, one upon each side, and are buttoned over the groins, as seen in Fig. 123.

Fig. 124.



Elastic suspensory bandage.

A very elegant suspensory is supplied by the shops, manufactured by weaving together cotton or silk threads, either alone or with caoutchouc threads. (Fig. 124.)

Use.—To support the scrotum, in orchitis; varicocele; and irreducible hernias.

§ 5. *Sheath Bandages.*

The Sheath of the Penis. *Composition.*—A sheath of muslin large enough to hold the penis is made, and to its base two strips of muslin are to be sewed sufficiently long to reach around the body. Cut a small hole in its apex to permit the passage of the urine.

Application.—Place the necessary dressings upon the penis and slip the sheath over them, conduct the two strips around the pelvis and knot them behind.

Use.—To sustain the penis upon the abdomen during inflammatory affections of that organ, and also to retain dressings upon it.

C. Mayor's Bandages for the Trunk.

The Cravat of the Neck. *Composition.*—A triangular piece of muslin folded in a cravat.

Application.—Place the body of the cravat upon any part of the neck, cross the lateral extremities upon the opposite side, and finally bring them back and knot them together. Mayor recommends the insertion of a piece of stiff paper in the folds of the triangle, or when suppuration is profuse, light wire gauze, to prevent the cravat's wrinkling.

Use.—To confine dressings upon the neck.

The Occipito-Thoracic Triangle (Occipito-Sternal). *Composition.*—Two triangular pieces of muslin, a yard and a quarter long by eighteen inches from the middle of the base to the apex; one is to be folded in a cravat.

Application.—Place the body of the cravat over the sternum and tie its lateral ends behind the back. The base of the triangle is now placed over the occiput, and its two extremities fastened in front to the sternal cravat after the head has been flexed to the necessary

extent; the apex is to be carried over and pinned upon either side of the bandage.

Use.—As a substitute for the flexor bandages of the head already described.

THE FRONTO-THORACIC TRIANGLE (FRONTO-STERNAL).—The only difference between the mode of applying this bandage and the preceding is that the base of the triangle should be placed upon the forehead instead of the occiput, and its tails tied to the cravat behind.

Use.—As a substitute for the extensor bandage of the head already mentioned.

THE PARIETO-AXILLARY TRIANGLE. *Composition.*—A triangular piece of muslin a yard and a quarter long and eighteen inches from base to apex.

Application.—Place the base of the triangle upon the parietal eminence on either side, carry the lateral angles under the opposite axilla, where they are to be tied, or else to a cravat, which has been preliminarily knotted around the shoulder of that side. The apex may be conducted around the head and pinned over either temple.

Use.—To bend the head to one side or the other, and to replace the figure of 8 bandage of the head and axilla.

THE THORACICO-SCAPULAR TRIANGLE. *Composition.*—A triangular piece of muslin a yard and a quarter long and eighteen inches from base to apex.

Application.—Place the base of the triangle beneath the part to which the dressings are applied either upon the anterior or posterior aspect of the chest, conduct its extremities to the opposite side, and tie them. The apex may be carried over the right or left shoulder, and connected, by lengthening it if necessary, with one of the extremities of the bandage.

THE SIMPLE BIS-AXILLARY CRAVAT (Fig. 125). *Composition.*—A piece of muslin a yard and a quarter long and eighteen inches deep, folded in a cravat.

Fig. 125.

Simple bis-axillary cravat.

Application.—Place the body of the bandage upon the diseased axilla after the dressings have been applied; the lateral extremities should then be crossed over the shoulder of the same side, and carried one behind and the other in front of the chest to the opposite axilla, where they are to be tied.

Use.—To retain dressings upon the axilla and to replace the retentive bandages of this region.

THE COMPOUND BIS-AXILLARY CRAVAT. *Composition.*—Two cravats a yard and a quarter long.

Application.—Place the body of one of the cravats upon one of the axillæ, and tie its extremities over the corresponding shoulder. The body of the other cravat is laid over the other axilla, and its extremities are carried one over the front, and the other behind the chest, looped around the first cravat, and tied in front.

Use.—To retain dressings upon both axillæ.

THE SIMPLE DORSO-BIS-AXILLARY CRAVAT. *Composition.*—A cravat a yard and a half long.

Application.—Place the body of the cravat between the shoulder-blades in an oblique direction so that one of its lateral extremities may pass over one shoulder and the other under the axilla of the opposite side, then bring the former under the axilla and the latter over the shoulder, and tie them together over the back.

Use.—To draw both shoulders backwards, thus fulfilling the same indications as the posterior figure of 8.

THE COMPOUND DORSO-BIS-AXILLARY CRAVAT. *Composition.*—Two cravats a yard long.

Application.—Place the body of one of the cravats in front of the left shoulder, and knot its extremities upon its opposite side, thus forming a kind of loose ring. The body of the other cravat is laid over the corresponding part of the right shoulder, and its extremities carried behind; the superior one looping around the cravat upon the opposite side, and the inferior extremity looping around the superior, when their ends are to be tied together.

Use.—The same as the preceding.

THE CRAVAT.—Triangular and oblong pieces of muslin may also be employed to retain dressings upon the chest and abdomen, and to make compression; their application is obvious.

THE TRIANGULAR CAP FOR THE BREAST. *Composition.*—A triangular piece of muslin a yard and a quarter long and eighteen inches deep.

Application.—Place the base of the triangle beneath the suffering organ, carry one of its extremities under the corresponding axilla, and the other over the opposite shoulder, and tie them together behind; the apex is conducted over the shoulder and pinned to the bandage behind.

THE CERVICO-THORACIC CRAVAT.—A cravat a yard and a quarter long, with its base placed upon the nape of the neck, and its extremities drawn down in front and pinned to a body bandage. It is principally employed as a scapulary.

THE CERVICO-DORSO-STERNAL CRAVAT. *Composition.*—A triangle of muslin a yard and a quarter long and eighteen inches deep.

Application.—Place its base upon the nape of the neck and bring its lateral extremities forward to be pinned to a body bandage, while its apex, hanging down the back, is fastened to the bandage behind.

Use.—To confine dressings upon the back.

THE SACRO PUBIC TRIANGLE (POSTERIOR PELVIC). *Composition.*—A triangle a yard and a quarter long and eighteen inches deep.

Application.—Place the base of the triangle upon the loins, conduct its extremities around the flanks, and tie them together in front

of the abdomen. The apex is now to be brought forward under the perineum between the thighs, and pinned to the extremities.

Use.—To retain dressings upon the posterior surface of the pelvis and perineum.

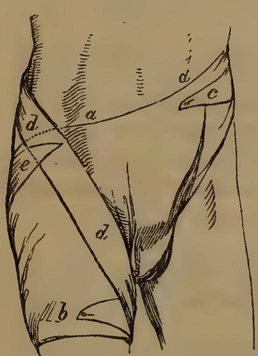
THE INTERCRURAL CRAVAT. *Composition.*—Two cravats, each a yard long.

Application.—Fasten one of them around the loins with pins, the body of the other cravat is placed over the perineum and its extremities brought upwards, one in front and the other behind the pelvis, and pinned to the first cravat.

Use.—To maintain topical dressings upon the perineum, anus, and vulva, and intended to replace the double T bandage used for the same purpose.

THE CRURO-PELVIC TRIANGLE (CRURO-INGUINAL) (Fig. 126). *Composition.*—A triangle a yard and a half from one extremity to the other, and two feet deep.

Fig. 126.



The cruro-pelvic triangle.

Application.—Place the base of the triangle obliquely across the groin; for instance, the right one, conduct the superior extremity around the left side, across the loins to the right groin, where it is pinned to the bandage. The inferior end should be carried around the upper part of the right thigh between it and the scrotum, to a point near the superior extremity, and fastened with a pin.

Use.—To keep dressings upon the groin, hip, and upper part of the thigh.

THE CRURO-PELVIC CRAVAT (INGUINAL). *Composition.*—A cravat a yard and a half long.

Application.—Place the body obliquely upon the diseased groin, we will say the right; then conduct its upper extremity behind around the left side to the right hip and its inferior one downwards just above the penis, across the upper part of the thigh, between it and the scrotum to the right hip, where the two ends are to be knotted together.

Use.—To maintain poultices and other dressings to the groin.

THE SACRO-BI-CRURAL CRAVATS. *Composition.*—Two cravats, each a yard and a quarter long.

Application.—Knot one of the extremities of each cravat together; then place this part of the bandage over the sacrum, and conduct each cravat around its corresponding side over both groins, backwards between the scrotum and thigh, one upon either side and around the upper parts of the thighs; the extremity of the right cravat should be pinned to the bandage over the groin of the left side, and that of the left cravat over the right groin.

Use.—For the same purposes as the double spica.

THE SACRO-LUMBAR TRIANGLE (SUSPENSORY) (Fig. 127). *Composition.*—1st. A triangle three-fourths of a yard long and a foot from its base to its apex. 2d. A cravat a yard long.

Application.—Surround the loins with the cravat, and then place the base of the triangle upon the back part of the scrotum; conduct its two lateral extremities upwards, and form loops around the cravat, passing from before backwards, and bring them to the median line, passing outside of that portion of the triangles in contact with the scrotum, when they are to be knotted together. The apex is now drawn upwards over the scrotum and penis, slipped under the knot, and the cravat reflected upon itself, and pinned.

Fig. 127.

The sacro-lumbar triangle.

Use.—This is used when a suspensory bandage is indicated.

The Coxo-Pelvic Triangle. *Composition.*—1st. A triangle a yard and a quarter long and eighteen inches deep. 2d. A cravat a yard and a half long.

Application.—Apply the cravat around the body just above the hips; then place the base of the triangle on the upper and posterior part of the thigh; conduct its extremities around this, cross them upon the opposite side, beneath the perineum, and finally bring them back and tie them together over the posterior surface of the thigh. Now draw the apex of the triangle upwards, loop it around the cravat, and fasten it with a pin.

Use.—To retain dressings upon the gluteal region.

D. Rigal's Bandages for the Trunk.

The Cervico-Axillary Cravat. *Composition.*—A cravat a yard long, and an India-rubber ring.

Application.—Place the body of the cravat upon the diseased axilla, and pass its extremities through the elastic ring over the opposite shoulder, when they are to be reflected upon themselves and tied together upon the opposite side of the neck.

Use.—Used as a retentive dressing for the axilla.

The Lateral Thoracic Bandage. *Composition.*—A handkerchief folded in a triangle.

Application.—Place the base of the triangle upon either the right or left side, over the false ribs; conduct its extremities circularly around the body to a point exactly opposite, and pin them together. Draw the two angles of the apex, one in front and the other behind the chest, to the opposite shoulder, over which they are tied.

Use.—This bandage covers in two-thirds of the chest, front and back, and is a ready means of retaining dressings upon extensive burns of that region.

The Sternal Triangle. *Composition.*—1. A handkerchief or square piece of muslin folded in a triangle; 2. An elastic thread.

Application.—Place the base of the triangle over the epigastrium, and carry its lateral angles around the body, and tie them upon its posterior surface; then raise the apex of the triangle to the root of the

neck, separate its angles, and conduct one upon either side of it to the nape of the neck, where they are to be knotted together; now loop the middle of the elastic thread around the upper knot, conduct the two halves vertically to the lower knot, to which they are also fastened with a thread, then separate them that they may pass over the nates, under the perineum, and around the outer surface of the hips, to the posterior portion of the iliac crest, where each thread loops around its own portion; they are finally brought forward again, one upon the right the other upon the left side, and fastened to the lower margin and middle of the base of the triangle.

Use.—Employed for retaining dressings upon the whole anterior portion of the chest.

THE DORSAL TRIANGLE.—This is applied in the same manner, only placing the triangle upon the posterior surface of the chest.

Use.—As a retentive bandage for the posterior surface of the chest.

THE THORACICO-ABDOMINAL BANDAGE. *Composition.*—A handkerchief folded in a triangle with the two angles of the apex truncated, and four elastic threads.

Application.—Place the base of the triangle transversely across the middle portion of the trunk with the apex hanging downwards; conduct its lateral angles around the body and knot them together behind; now raise the anterior angle to the top of the sternum, and support it in that position by an elastic thread passing around the nape of the neck and fastened to its two corners. To each corner of the inferior angles elastic threads are attached, which pass backwards between the thighs around the upper and outer surface of the hip, one upon each side, to be fastened to the bandage in front just above the groin.

To prevent the elastic ring round the neck working up, a cord of the same material connects it vertically with the knot upon the middle line of the back.

Use.—This bandage will serve very well to retain lint or other dressings upon burns of a large extent of the anterior surface of the body.

THE GIRDLE. *Composition.*—A cravat a yard and a quarter long, and an elastic ring.

Application.—Place the body of the cravat upon the abdomen and conduct its extremities to the posterior surface of the body, where they are passed through the elastic ring, and are then brought forward again and pinned to the body of the cravat over the loins.

Use.—To support the abdomen when pendulous.

SECTION III.

BANDAGES OF THE UPPER EXTREMITIES.

SIMPLE BANDAGES.

Circular Bandages.
- The circular bandage of a finger.
- The circular bandage of the forearm.
- The circular bandage of the arm.

Spiral Bandages.
- The spiral bandage of a finger.
- The spiral bandage of all the fingers (Gauntlet).
- The spiral bandage of the hand and fingers.
- The spiral bandage of the forearm.
- The spiral bandage of the arm.
- The spiral bandage of the whole arm.

Figure of 8 Bandages.
- The figure of 8 bandage of the thumb and wrist.
- The posterior figure of 8 bandage of the hand and wrist.
- The anterior figure of 8 bandage of the hand and wrist.
- The figure of 8 bandage of the elbow.
- The extensor figure of 8 bandage of the hand and forearm.
- The flexor figure of 8 bandage of the hand and forearm.

Recurrent Bandages.
- The recurrent bandage of a stump of the arm and forearm.
- The recurrent bandage after disarticulation at the shoulder.

Bandages.
- The large quadrilateral scarf of the arm and chest.
- The oblique quadrilateral scarf of the arm and chest.
- The scarf of the arm and neck.
- The scarf of the hand and forearm.

COMPOUND BANDAGES.

T Bandages.
- The simple T bandage of the hand.
- The double T bandage of the hand.
- The perforated T bandage of the hand.

Sling Bandages.
- The sling bandage of the hand.
- The anterior sling bandage of the elbow.
- The posterior sling bandage of the elbow.

Sheath Bandages.
- The sheath bandage of the fingers.

Laced and Buckle Bandages.
- The laced bandage of the arm.
- The laced bandage of the body (strait jacket).

MAYOR'S BANDAGES OF THE UPPER EXTREMITIES.

- Cravats, triangles, and squares.
- The carpo-digito dorsal triangle.
- The interdigital triangle.
- The palmo-digito-brachial triangle.
- The carpo-olecranon cravat.
- The carpo-cervical triangle.
- The cervico-brachial triangle.
- The triangular cap of the shoulder.
- The triangular cap of stumps.

RIGAL'S BANDAGES OF THE UPPER EXTREMITIES.

- The deltoid bandage.

A. Simple Bandages.

§ 1. *Circular Bandages.*

The Circular Bandage of a Finger (Fig. 128). *Composition.*—A piece of muslin a yard and a quarter long and three-quarters of an inch wide.

Fig. 128.

Circular bandage of a finger.

Application.—Permit a few inches of the initial extremity of the bandelette to remain free, exhaust the balance of it by circular turns around the finger, and knot the two ends together. Or when the initial end is confined, the terminal one should be split in two a few inches, and then carried around the finger in opposite directions and tied. A piece of thread will answer the same purpose of retaining the bandage.

Use.—The common retentive bandage in popular use for injuries of the fingers.

The Circular Bandage of the Forearm. *Composition.*—A bandelette a yard and a quarter long and one inch and a half to two inches wide.

Application.—The initial extremity is confined to the wrist by a circular turn, and the bandage exhausted, when the terminal end may be fixed by any of the methods above mentioned.

Use.—To confine dressings to a limited portion of the forearm.

The Circular Bandage of the Arm. 1*st Variety.*

The composition, mode of application, and use of this bandage are the same as the circular bandage of the forearm.

2*d Variety, for venesection.*

Composition.—A strip of muslin a yard and a quarter long by three inches wide, folded upon itself in the direction of its length.

Application.—Let the patient be seated upon a chair opposite the surgeon, who supports the hand of that arm upon which the venesection is to be performed, pressed against his chest; then take the body of the bandelette between the fingers of both hands, and place it about an inch above the point where the puncture is to be made, conduct its extremities backwards, cross them upon the posterior face of the limb and bring them forwards, when they are to be tied in a single bow-knot upon the outer margin of the arm.

The amount of constriction should be sufficient to interrupt the return of blood in the vein, without arresting the pulsation in the radial artery; for this would defeat the object in view by cutting off the supply of blood to the vein.

Use.—This bandage is employed exclusively in venesection.

§ 2. *Spiral Bandages.*

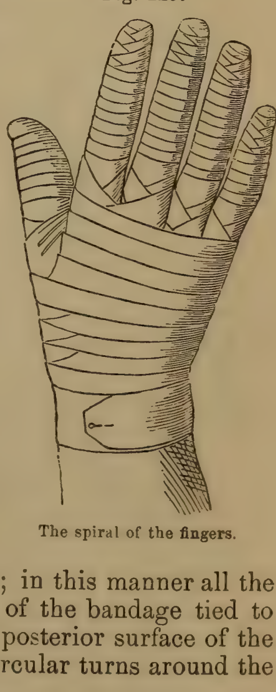
The Spiral Bandage of a Finger. *Composition.*—A strip of muslin a yard and a half long and three-quarters of an inch wide.

Application.—If a finger of the right hand is to be bandaged, place it in a prone position; then, permitting three or four inches of the initial extremity to hang free from the ulnar border of the wrist, make two circular turns around this part; when the roller arrives at the fifth metacarpal articulation, cross the back of the hand obliquely to the radial margin of the base of the finger (the index, if you please), which is to be covered by spiral turns to its point; and returning, these are inclosed by circular turns, each of which should overlap a half of its predecessor, until the ulnar border of the base of the finger is reached, when the roller passes obliquely across the back of the hand, crossing the previous turn, to the radial border of the first metacarpal bone, and thence around to the ulnar border of the wrist, where the initial and terminal extremities of the bandage should be knotted together.

Use.—To make compression upon the finger, and to retain dressings and splints upon it.

The Spiral of the Fingers (the Gauntlet) (Fig. 129). *Composition.*—A roller eight yards long and three-quarters of an inch wide.

Fig. 129.



The spiral of the fingers.

Application.—Place the hand in a position of pronation, and if the left hand is to be bandaged, let three or four inches of the initial extremities hang free from the radial border of the wrist; then make two circular turns of this part, and when the roller arrives at the styloid process of the radius conduct it obliquely across the hand to the ulnar margin of the base of the little finger, which is to be inclosed with spiral turns to its point; returning, make circular turns, each of which ought to overlap half the width of its own predecessor, until the radial margin of its base is reached, when the roller should be made to pass around the lower part of the ulnar border of the hand, across its palm to the radial border of the wrist; whence it again takes its departure to cross the back of the hand to the base of the ring finger, which is covered in the same manner as the previous one, and then the roller returns again around the ulnar border of the hand across the palm to the point of departure; in this manner all the fingers are covered in, and the terminal end of the bandage tied to the initial end in a double bow-knot over the posterior surface of the wrist; or the bandage may be completed by circular turns around the hand, as seen in the figure.

Use.—To prevent adhesions between the adjacent margins of the

fingers during the healing process after burns; to make pressure upon the hand and fingers, and as a retentive bandage in fractures and dislocations of the phalanges.

THE DEMI GAUNTLET (Fig. 130). *Composition.*—A roller five yards long and three-quarters of an inch wide.

Fig. 130.

The demi-gauntlet.

Application.—The hand should be placed in the same position as in the previous case, and if it be the left one which is being bandaged, let two or three inches of the initial extremity of the roller hang free from the radial border of the wrist, which is encircled twice; and when the cylinder arrives at this point again, at the end of the second turn it should be conducted obliquely across the dorsum of the hand to the ulnar margin of the base of the little finger; then in front of this and around between it and the ring-finger to the ulnar margin of the hand; around this, across the palm, to the radial margin of the wrist, whence the roller crosses the dorsum of the hand to pass around the base of the ring-finger, and back again, as in the previous turns. In this manner, pass around the roots of all the fingers; and finally, when the band is exhausted, knot its extremities together over the wrist.

Use.—As a retentive bandage in dislocations of the first phalanges upon the metacarpal bones, and also to maintain dressings upon the back of the hand, for which purpose it is well adapted by its simplicity and lightness.

THE SPIRAL BANDAGE OF THE FINGERS AND THE HAND. *Composition.*—A roller four yards long and an inch and a half wide.

Application.—Place the hand prone, and confine the initial extremity of the roller by two circular turns around the fingers; proceed upwards by circulars to the base of the thumb, where the irregularity of the parts will demand more or less reverses, which should be one above another in the median line of the hand; terminate the bandage by two or three circular turns around the lower portion of the forearm, and pin the terminal end.

Use.—To maintain in position apparatus for fracture of the bones of the hand, and to make pressure upon the parts.

THE SPIRAL OF THE FOREARM. *Composition.*—A roller two yards and a half long and one inch and a half wide.

Application.—Confine the initial extremity by circular turns around the wrist, then ascend the forearm, making the required number of reverses to permit the bandage to lie smoothly on the limb, and terminate by two or three circular turns around the lower portion of the arm.

Use.—To support topical applications upon the forearm.

THE SPIRAL BANDAGE OF THE ARM. *Composition.*—A roller two yards and a half long and an inch and a half wide.

Application.—Confine the initial end below the elbow, and ascend the arm by circular and reverse turns, until it is entirely inclosed to the axilla, when the bandage is terminated by circular turns.

Use.—The same as the preceding.

The Spiral Bandage of the Whole Arm (Fig. 131). *Composition.*—A roller twelve yards long and an inch and a half wide.

Application.—As the three preceding bandages go to make up the spiral of the whole arm, or, in other words, are so many sections of it, there will be no necessity of describing it in detail. It is begun exactly as the spiral of the hand, and terminated as that of the arm. Care should be taken to make a sufficient number of reverses to enable the bandage to embrace the limb evenly and neatly.

Use.—This bandage is often employed in treatment of fractures of the bones of the arm and forearm, to prevent engorgement of the extremity; to make uniform pressure over a large extent of surface in inflammatory affections of the skin and cellular tissues, as in erysipelas, and especially where there are large collections of pus, detaching the integuments from the subjacent parts; to arrest hemorrhage from wounded arteries; or to retard the current of blood circulating through them in aneurismal cases; and, lastly, to retain dressings upon the whole extent of the limb after scalds and burns.

Fig. 131.

The spiral bandage of the whole arm.

§ 3. *Crossed Bandages.*

The Crossed Bandage of the Thumb (The Spica). *Composition.*—A roller two yards and a half long and two-thirds of an inch wide.

Application.—Let the hand be placed in a position of pronation, the right hand, for instance, then permit three or four inches of the free end of the roller to hang from the ulnar margins of the wrist, around which two or three circular turns are to be made; arriving at the fifth carpo-metacarpal articulation, passing from the ulnar to the radial border, cross the back of the hand obliquely to the radial border of the second phalangeal articulation of the thumb, and in front of it, to its ulnar border, over its dorsum, crossing the previous turn at this point, then down around the radial border of the hand across the palm of the hand to its ulnar border, the point where the first oblique turn

began. In a similar manner make a sufficient number of these turns to cover in the thumb completely, each one of which should overlap half the width of its predecessor, forming an ascending spica. When the turns are made from the base towards the point of the thumb, the spica is said to be *descending*. Terminate the bandage by knotting the extremities together over the back of the wrist.

Use.—To keep dressings upon the thumb, and to make compression in dislocation of the carpo-metacarpal articulation. This spica may be applied in a similar manner to any of the fingers.

THE POSTERIOR FIGURE OF 8 OF THE HAND AND WRIST. *Composition.*—A roller seven yards long and two inches wide.

Application.—Let the hand be pronated, the left, for instance, then allowing three or four inches of the roller to hang free from the radial border of the wrist, make two circular turns about this part; arriving at the first carpo-metacarpal articulation, pass obliquely across the hand to the base of the little finger, then across the palmar surface of the first phalanges, around the radial border of the index finger, and back transversely over the dorsal surface of the first phalanges; thence around to the first metacarpo-phalangeal articulation, across the palmar surface again to the base of the index finger; now cross the dorsum of the hand obliquely to the ulnar margin of the wrist, making a cross with the previous turn over the metacarpal bones, around which one circular turn should be made, when the roller will arrive at the radial margin of the wrist—the point of departure. Go over this course once or twice more, and terminate the bandage by knotting the ends together at the wrist.

Use.—For retaining dressings upon the posterior surface of the hand and to make compression upon that part after dislocation of the carpal and metacarpal bones; and also upon ganglionic tumors of this region.

THE ANTERIOR FIGURE OF 8 OF THE HAND AND WRIST. *Composition.*—The same as for the posterior figure of 8.

Application.—The turns of the bandage are made in the same general manner as in the previous bandage, only the crosses are placed over the palm.

Use.—To retain dressings upon the palm.

THE FIGURE OF 8 OF THE ELBOW. *Composition.*—1st, a roller bandage four yards long and two inches wide; 2d, a square compress of patent lint or muslin.

Application.—In applying the figure of 8 of the elbow to the right arm, let it be placed in a position of supination; place the compress on the wounded vein, and then allowing three or four inches of the initial end of the bandage to hang free from the outer margin of the arm, at a point three inches above the compress, make a circular turn, and, arriving at the outer margin of the elbow, conduct the roller obliquely over the compress to the ulnar margin of the forearm, around the upper part of which one circular turn is to be made, and then passing from its radial border cross the compress again to the inner margin of the arm, and pass over its posterior surface to its outer margin—the point of departure. Repeat this course once again, and terminate the

bandage by knotting the ends of the roller upon the outer border of the arm.

Use.—To maintain a compress over a vein punctured in venesection. After the bandage is applied the arm should be semi-flexed and carried in a sling until the little wound made by the lancet shall have cicatrized.

THE EXTENSOR FIGURE OF 8 OF ARM AND HAND. *Composition.*—A roller six yards long and two inches wide, wound in two cylinders or heads.

Application.—Let the hand be pronated and strongly extended upon the forearm, place the body of the roller upon the posterior surface of the hand, just above the metacarpo-phalangeal articulation; then conduct the two heads across the palm in opposite directions and bring them to the dorsum, where you cross them with a reverse, to go to the palm, whence they are brought again to the dorsum. Now passing in opposite directions, one of the heads is conducted around the radial margin of the hand obliquely across the forearm to the outer condyle, the other around its ulnar border obliquely across the former band to the inner condyle; they are then crossed above the olecranon, to be brought circularly to the front aspect of the arm, crossed here, and the upper turn reversed upon the lower, when they are passed posteriorly, and crossed above the olecranon; afterwards one roller courses along the radial border of the forearm to the ulnar border of the hand and to the palm, and the other turns around the inner border of the arm, crossing the forearm to the radial border of the hand and palm. In this manner two or three turns may be made, and the bandage exhausted by circular turns of the hand.

Use.—To prevent vicious cicatrices of the palm after burns producing deformities of the hand.

THE FLEXOR FIGURE OF 8 OF THE HAND AND ARM. *Composition.*—Same as the previous bandage.

Application.—The hand should be in a state of forced flexion, and the body of the bandage placed upon its palm; the rest of the bandage is executed in the same manner as the extensor figure of 8.

Use.—To prevent cicatrices of the dorsum of the hand, producing deformity.

§ 4. *Recurrent Bandages.*

THE RECURRENT BANDAGE AFTER AMPUTATION OF ARM AND FOREARM. *Composition.*—A roller seven yards long two inches wide, wound in two heads.

Application.—This is applied in the same manner as the recurrent of the lower extremities after amputation.

THE RECURRENT BANDAGE OF THE SHOULDER (AFTER DISARTICULATION). *Composition.*—A roller twelve yards long and two inches wide, wound in two unequal heads.

Application.—Apply the proper dressings, compresses, and a Maltese cross over the shoulder, then place the body of the roller upon the axilla of the sound side, and bring the two heads obliquely across the chest, one in front, and the other behind, to the acromion process above the wound. At this point the anterior cylinder should be reversed

upon itself, and brought down vertically behind the wound, to a point two inches below it; the posterior cylinder continues its original course across the reverse, and down obliquely from the point of the shoulder to the opposite side, and around the chest circularly to cross the vertical turn of the other head, which is now reflected upwards, so as to form a loop around the circular turn, to the acromion again. The cylinder coursing horizontally now passes in front of the chest, around the side, and obliquely over the back to the acromion, to cross the second vertical turn and fix it above, while the roller making the vertical turns descends again over the wound. Continue in this manner to make vertical turns with one of the heads of the roller, and horizontal and oblique turns with the other until the shoulder is entirely covered. Terminate the bandage by two or three circular turns around the chest.

Use.—To retain dressings upon the shoulder after disarticulation.

§ 5. *Handkerchief Bandages.*

THE LARGE QUADRILATERAL SCARF OF THE ARM AND CHEST. *Composition.*—A piece of muslin about one yard and an eighth long, and two feet and a quarter broad.

Application.—Place one of the long borders of the piece of muslin transversely across the chest and below the breasts; conducting its angles posteriorly, fasten them together over that part of the thorax opposite the injured side. Now raise the inferior border upwards, after having bent the forearm, at an angle of 45°, over the whole upper extremity, and carry one of its angles over the shoulder of the injured side, and the other under the axilla of the opposite side, and tie or pin them together upon the back.

Use.—This bandage answers the purpose of supporting the whole arm, and retaining it in contact with the chest. It may be also applied when the bandage of Desault is employed in the treatment of fracture, that the turns of the latter may be pinned to it.

THE LARGE TRIANGULAR SCARF OF THE ARM AND CHEST. *Composition.*—A piece of muslin a yard and one-eighth square, folded in a triangle.

Application.—Place the base of the triangle transversely across the chest below the mammæ, conduct its extremities posteriorly, and tie or pin them together upon the side opposite the affected arm. Raise its apex over the arm after this has been bent to an angle of 45°, or any desired angle, and carry it over the shoulder of the injured side, to be attached to the bandage behind, using a short strip of muslin if it should be not sufficiently long to reach.

Use.— This bandage will answer the same indications as the former; but from the fact of its being double, is more heating and is not so solid.

THE LARGE OBLIQUE SCARF OF THE ARM AND CHEST. *Composition.*—A piece of muslin a yard and one-eighth square, folded in a triangle.

Application.—Let the arm be bent at an angle of 45° and directed across the chest; then, taking the middle of the base of the triangle

in both hands, the surgeon glides it under the elbow and along the under surface of the forearm to the hand. Its lateral extremities are then conducted upwards, one in front of the arm and chest, and the other behind the chest, to the shoulder of the healthy side, over which they are to be tied. Now bring the apex of the triangle around the outer margin of the arm and pin it to the anterior extremity.

Use.—To sustain the arm and forearm.

The Scarf of the Forearm and Neck. *Composition.*—A triangular piece of muslin a yard and three-eighths along its base and two feet from base to apex.

Application.—Flex the forearm to the desired angle, then glide the base of the triangle under the elbow, along the forearm to the hand, and conduct its extremities upwards, one between the arm and chest over the shoulder corresponding to the injured side, the other over the forearm, across the chest to the opposite shoulder; then tie or pin them together over the nape of the neck. Fold the apex under the elbow if it should project beyond this point.

Use.—This is the common sling used to support the forearm in fractures of its bones, or in inflammatory or other diseased condition of the hand.

The Scarf of the Hand and Forearm. *Composition.*—A piece of muslin half a yard long and 8 or 12 inches wide.

Application.—Place the hand and the lower part of the forearm upon the middle of the muslin, carry its ends upwards, and pin their corners to the clothes over the chest.

Use.—To support the weight of the hand and a portion of the forearm, in inflammatory or other diseased condition of these parts requiring them to be suspended in an elevated position.

B. Compound Bandages.

§ 1. T *Bandages.*

The Simple and Double T Bandages of the Hand. *Composition.*—A roller two feet and a half long, by one inch wide: at right angles to this, and four inches from its initial extremity, if it is desired to form a single T, sew the end of a strip of muslin two feet long and two thirds of an inch wide; if a double T is required, the ends of two such strips must be tacked to the horizontal one, the first at three, and the second at five inches from its initial extremity.

Application.—Give the hand a prone position, and then place the initial extremity of the horizontal band at that part of the wrist where, upon making one circular turn, the two vertical strips will correspond with the first and fourth inter-metacarpal spaces, one over each; they should then be carried between the two corresponding fingers to the palm and wrist, at which latter point the circular band passes around them. The vertical strips are looped around it and reflected downwards, the first one passing between the index and middle fingers, the other between the middle and ring fingers, to the back of the hand and wrist, where they are confined by being tied together over a circular turn. The bandage is terminated by circular turns around the wrist.

The single T is applied in the same manner; the vertical strips cover but two of the metacarpal spaces.

Use.—A light retentive bandage for retaining dressings upon the dorsum and palm of the hand; and is also used to prevent adjacent fingers uniting at their bases during cicatrization after burns.

The Perforated T of the Hand. *Composition.*—A piece of muslin ten to twelve inches long and three to four inches wide, perforated at its middle by five holes for the fingers, and having sewed to one of its ends the middle of a strip of muslin a foot and a half long and an inch wide.

Application.—Engage the fingers in the holes, and draw the extremity having the strip attached over the back of the hand to the wrist; then, in like manner, arrange the other extremity upon the palm and front of the wrist, and fix them both, by circular turns of the strip, to this part; finally knot its ends together.

Use.—Answers the same indication as the preceding bandage.

§ 2. *Sling Bandages.*

The Anterior Sling Bandage of the Hand. *Composition.*—A piece of muslin sixteen inches long and three or four inches wide, split at each extremity, so as to leave an intervening portion of three inches.

Application.—Place the body of the sling upon the palm of the hand, and tie its inferior extremities around the base of the fingers, and its superior ones around the wrist.

Use.—To confine dressings upon the palm of the hand.

The Anterior Sling of the Elbow. *Composition.*—A piece of muslin eighteen inches long and three or four wide, split at each extremity in two tails.

Application.—Place the body of the sling upon the bend of the elbow, and tie its inferior ends around the upper portion of the forearm, and its superior ones around the arm.

The posterior sling is made in the same manner; its body is applied over the olecranon.

Use.—To maintain topical applications upon the front and back aspects of the elbow.

§ 3. *Sheath Bandages.*

The Sheath for the Finger. *Composition.*—A sheath of muslin resembling the finger of a glove, large enough to cover the finger and the dressings upon it, and having attached to the posterior portion of its base two threads, or a strip of muslin.

Application.—Slip the sheath over the finger and tie the threads around the wrist to prevent its slipping off, or fix the end of the strip of muslin to the same part, by two threads attached to its angles. The finger of a glove will often answer the same purpose as the sheath.

Use.—To maintain dressings upon the fingers.

§ 4. *Laced and Buckled Bandages.*

The Strait Jacket. *Composition.*—A stout piece of canvas, sufficiently wide to surround the trunk and long enough to reach from

the top of the shoulder to the middle of the thighs. Along its lateral margins a series of corresponding eyelet holes are worked, or, what will equally answer, a number of little loops. Upon the inner surface of the canvas, at each side corresponding to the shoulders, two long pieces of the same material are sewed, forming sheaths for the arms. At the extremities of the sleeves holes are cut through the canvas for the hands to project exteriorly, that the pulse at the wrist may be within reach of the physician.

Application.—Slip the arms into the sleeves, and bring the canvas up snugly around the body, and, having drawn the eyeletted margins behind, lace them together with a stout cord. To still further restrain the movements of the patient, a number of loops may also be fastened to the top, bottom, and sides of the jacket, through which a cord may be passed and tied to the bedstead. A more comfortable arrangement is to place the patient's hands in leathern mittens with a strong loop at each wrist, through which a leathern strap passes, and buckles around the patient's waist.

Use.—To restrain the violence of the insane, and of those unmanageable from delirium or other causes.

THE LACED BANDAGE OF THE ARM. *Composition.*—A piece of muslin three or four inches wide, sufficiently long to encircle the arm, and perforated at its extremities by four holes at equal intervals. Take two pair of doubled cords, one of which is passed through the two upper holes in such a manner that their extremities go in opposite directions and leave a loop upon each margin of the muslin. Arrange the other pair in the same way in the lower holes, and then knot the four extremities together upon each side, an inch from the bandage, and cut off all the ends but one.

Application.—Slip the bandage over the arm, arrange it properly over the dressings upon that part, and draw the cords in opposite directions to approximate its edges, and terminate the bandage by two circular turns of the cords around the arm.

Use.—To retain dressings upon the arm after blistering, applying the moxa, etc.

C. MAYOR'S BANDAGES FOR THE UPPER EXTREMITIES.

CRAVATS, TRIANGLES, AND SQUARES FOR THE FINGERS, HAND, FOREARM, AND ARM.—Cravats are in popular use, and employed daily for the more trifling injuries of the arms, applied either circularly around the parts or variously arranged, forming crossed or figure of 8 bandages of the hand and wrist, and of the elbow. They are frequently effectual substitutes for the more complicated roller bandages. The same remark applies to oblong pieces of muslin, which are applied circularly around the limbs, and pinned at their corners.

THE CARPO-DIGITO-DORSAL TRIANGLE, AND THE CARPO-DIGITO-PALMAR TRIANGLE. *Composition.*—A triangular piece of muslin twenty inches long, and ten inches from its base to its apex.

Application.—Place the base of the triangle upon the anterior or posterior aspect of the wrist, cross its angles behind, and tie them

together upon the opposite side; then conduct the apex of the triangle over the ends of the fingers and palm of the hand in the carpo-digito-dorsal triangle, and in the reverse direction in the carpo-digito-palmar triangle, and pin it at the wrist.

Use.—The first form of the bandage is intended to secure forced flexion, and the second forced extension of the wrist and fingers. They may also be used as retentive means for applications upon the anterior and posterior aspects of the hand.

THE INTERDIGITAL TRIANGLE. *Composition.*—A triangular piece of muslin twelve inches long and eight inches high. A short distance above its base pierce five holes for the fingers to pass through.

Application.—Engage the fingers through holes, and draw the base of the triangle to the wrist, around which its lateral angles are tied; then, in like manner, pull its apex down to the wrist upon the opposite side, and pin it.

Use.—To prevent the union of the fingers during cicatrization after burns; it may also be used as a retentive bandage for dressings upon the dorsum and palm of the hand.

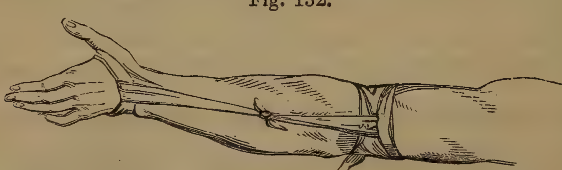
THE PALMO-DIGITO-BRACHIAL TRIANGLE. *Composition.*—1st. A triangular piece of muslin a yard and an eighth long from end to end, and seventeen inches high. 2d. A cravat, two feet and a half long.

Application.—Fasten the cravat circularly around the arm just above the elbow, then place the base of the triangle upon the palmar surface of the wrist around which its lateral angles are tied; conduct its apex over the points of the fingers placed in a position of forward extension, and fasten it to the cravat at the elbow.

Use.—The bandage is employed in wounds and burns about the wrist, according to the circumstances of the case, to prevent deformity during cicatrization.

THE CARPO-OLECRANON CRAVATS (Fig. 132). *Composition.*—Two cravats a foot and a half long, and a third cravat a yard and a quarter long.

Fig. 132.



The carpo-olecranon cravat.

Application.—Encircle the arm just above the elbow with one of the short cravats, and the hand with the other; then forcibly extend the hand upon the forearm and connect the two cravats by the long one looped around them, and tie its extremities upon the outer aspect of the arm; or the hand may be forcibly flexed before the third cravat is arranged.

Use.—These two forms of carpo-olecranon cravats are employed as substitutes for the extensor and flexor figure of 8 bandages of the

arm and hand, and, conjoined with a short splint upon the front of the elbow, are used in fractures of the olecranon process.

THE CARPO-CERVICAL CRAVATS. *Composition.*—Two cravats; one, two feet long, the other, a yard.

Application.—Tie the short cravat loosely around the neck, then place the lower part of the forearm, flexed at right angles with the arm, upon the middle of the long cravat, and conduct its extremities upwards and tie them to the cervical cravat.

Use.—To support the arm, and keep it flexed during the union of wounds upon the anterior aspect of the elbow, or cicatrization of burns about the olecranon.

THE CERVICO-BRACHIAL TRIANGLE. *Composition.*—A cravat two feet long, and a triangle a yard long and sixteen inches high.

Application.—Knot the cravat loosely around the neck with the tie in front, then slide the base of the triangle under the elbow along the under surface of the forearm to the hand, conduct its two lateral angles upwards, one upon each side of the arm, and fasten them to the cervical cravat. Bring its apex around the outer border of the arm, and fasten it to the bandage in front.

Use.—To support the forearm, and is used as a substitute for the scarf bandages.

THE TRIANGULAR CAP FOR THE SHOULDER. *Composition.*—A cravat two feet long, and a triangle a yard long and sixteen inches high.

Application.—Place the body of the cravat in the axilla of the sound side, and tie its tails together over the opposite shoulder; then place the base of the triangle below the wound upon the upper and outer third of the arm around which its tails or lateral angles are to be tied; the apex of the triangle is then carried over the point of the shoulder, and fastened to the cravat.

Use.—To retain dressings upon the shoulder.

THE TRIANGULAR CAP FOR THE SHOULDER (AFTER DISARTICULATION). *Composition.*—Same as in the previous bandage.

Application.—Fasten the cravat as was done in the previous bandage; place the base of the triangle below the wound, then reflect its three angles upwards, and fasten them to the cravat above the shoulder.

Use.—To maintain dressings upon the shoulder after disarticulation.

D. RIGAL'S BANDAGES FOR THE UPPER EXTREMITIES.

THE DELTOID BANDAGES. *Composition.*—A square piece of muslin folded in a triangle, and elastic cords.

Application.—Place the base of the triangle upon the upper third of the arm, carry its lateral angles around this part and knot them upon its outer side; draw the apex of the triangle towards the neck, pulling one of its parts in front and the other behind, and tie them together over the sound shoulder.

To render the bandage more firm, an elastic cord is attached to the margin of the triangle in front and behind, passing beneath the sound axilla; a second elastic cord is tied anteriorly and posteriorly, to the

first cord and above to the knot formed by the tails of the triangle upon the shoulder.

Use.—To retain dressings upon the shoulder.

SECTION IV.

BANDAGES OF THE LOWER EXTREMITIES.

SIMPLE BANDAGES.

- Circular Bandages.
  - The circular bandage of a toe.
  - The circular bandage of the leg.
- Spiral Bandages.
  - The spiral bandage of a toe.
  - The spiral bandage of the leg.
  - The spiral bandage of the thigh.
  - The spiral bandage of the lower extremity.
- Figure of 8 Bandages.
  - The figure of 8 bandage of a toe.
  - The figure of 8 bandage of the foot and leg.
  - The posterior figure of 8 bandage of the knee.
  - The anterior figure of 8 bandage of the knee.
  - The figure of 8 bandage of both knees.
- Recurrent Bandages.
  - The recurrent bandage of the leg.
  - The recurrent bandage of the thigh.
  - The recurrent bandage of the hip.
- Invaginated Bandages.
  - The invaginated bandage for longitudinal wounds.
  - The invaginated bandage for transverse wounds.

COMPOUND BANDAGES.

- T Bandages.
  - The single T bandage of the foot.
  - The double T bandage of the foot.
- Sling Bandages.
  - The sling bandage of the instep.
  - The sling bandage of the heel.
  - The sling bandage of the knee.
- Sheath Bandages.
  - The sheath bandage of a toe.
- Laced Bandages.
  - The laced bandage of the lower extremity.

MAYOR'S BANDAGES FOR THE LOWER EXTREMITY.

- Cravats, triangles, and squares of the toes, foot, leg, and thigh.
- Imbricated squares and cravats.
- The tibial triangle.
- The popliteal cravat.
- The tarso-patellar cravat.
- The compound metatarso-patellar cravat.
- The tarso-pelvic and tarso-crural cravats.
- The triangular cap for stumps.
- The triangular cap for the heel.
- The metatarso-malleolar cravat.
- The malleolar-phalangeal triangle.
- The tibio-cervical cravat.
- The uniting cord for longitudinal wounds.

RIGAL'S BANDAGES FOR THE LOWER EXTREMITY.

- The triangle of the trochanter major.
- The bandage for the leg.
- The bandage for the foot.

A. Simple Bandages.

§ 1. *Circular Bandages.*

The Circular Bandage of a Toe.—The composition and application of this bandage are the same as that of the circular bandage of a finger already described.

The Circular Bandage of the Leg for Venesection. *Composition.*—A slip of muslin a yard long and three inches wide, folded in the direction of its length.

Application.—Place the body of the bandelette upon the leg two or three inches above the malleoli, conduct its extremities around the limb, cross them upon its opposite side, and finally regain the place of departure, when they are to be tied in a single bow-knot either upon the inner or the outer side of the leg, according as the vein to be punctured is upon the outer or inner surface of the foot; the knot being always opposite to it, that the ends may not be soiled nor interfere with the flow of blood.

Use.—This bandage is used exclusively in venesection in the foot, serving to arrest the return of venous blood. It will be necessary to draw it pretty tight; and the foot may be previously immersed for half an hour in hot water to facilitate the congestion of the veins.

§ 2. *Spiral Bandages.*

The Spiral Bandage of the Toe.—The composition and application of this bandage are the same as those of a spiral of a finger already described.

The Spiral of all the Toes.—The composition and application of this bandage are also the same as those of the gauntlet or spiral of all the fingers.

The Spiral of the Foot. *Composition.*—A roller four yards long and two inches wide.

Application.—If the right foot is to be bandaged, let the patient be seated in front of the surgeon with the heel upon his knee; then make two circular turns around the ankle to confine the initial extremity; when the roller arrives at the external malleolus, conduct it across the dorsum of the foot to the root of the big toe; here change its direction, and make circular and reverse turns around the forepart of the foot to near the middle of its outer border; now pass from this point up over the instep, down its inner side, and across the apex of the heel to its outer side, then across the instep, again, and around under the heel, covering in the lower third of the previous turns; in like manner make a third turn around the heel, which should cover in the upper third of the first one; and at the termination of this, when the roller comes to the top of the foot, carry it around its inner border under the sole, around the outer malleolus and the tendo-Achilles, and obliquely upon the inner surface of the os calcis across the sole of the foot to its outer border. From this point the cylinder comes obliquely across the instep around the tendo-Achilles and over the outer surface of the os calcis, under the foot to its inner margin

and up over the instep, and round the lower portion of the leg, when the bandage is terminated by two or three circular turns. In this manner the heel is perfectly and neatly covered in, and the entire surface of the foot from the root of the toes to the leg compressed in a uniform manner.

Use.—This bandage is employed almost exclusively for the purpose of making compression upon the foot; when the object is simply to retain dressings upon the part, the covering of the point of the heel may not be so much regarded. In the French spiral, the heel is left exposed, and is very apt to swell, and become painful from the inequality of the pressure.

THE SPIRAL OF THE LEG. *Composition.*—A roller seven yards long and two inches wide.

Application.—Place the patient in the same position as directed above, and confine the initial extremity about the lower part of the leg by two circular turns, and then ascend to the knee by circular and reverse turns, and terminate the bandage below it by two circular turns. When, however, uniform pressure is desired, the foot should be included. In the ordinary spiral the initial extremity is confined around the ankle—we will say the right—and the roller conducted from the outer malleolus across the dorsum of the foot to the root of the big toe, then ascend the foot by circular and reverse turns to the anterior part of the heel, when the roller courses over the instep and around the lower portion of the leg which is covered in to the knee by circular and reverse turns. What has been called the French spiral differs from the preceding in that its initial extremity is confined around the forepart of the foot by circular turns; its succeeding portion is executed in exactly the same manner.

Use.—To confine dressings upon the leg, and to make uniform pressure, as in chronic ulcers of that part, or in diffuse phlegmonous inflammation.

THE SPIRAL OF THE THIGH. *Composition.*—A roller seven yards long and two inches wide.

Application.—Place the initial extremity of the roller upon the lower part of the thigh, and confine it there by two or three circular turns; then ascend towards the hip by circular and reverse turns, and terminate the bandage by one or two turns around the pelvis.

Use.—As a retentive for blisters, poultices, etc., applied to the thigh.

THE SPIRAL OF THE LOWER EXTREMITIES (Fig. 133). *Composition.*—Two rollers, each eight yards long and two inches wide.

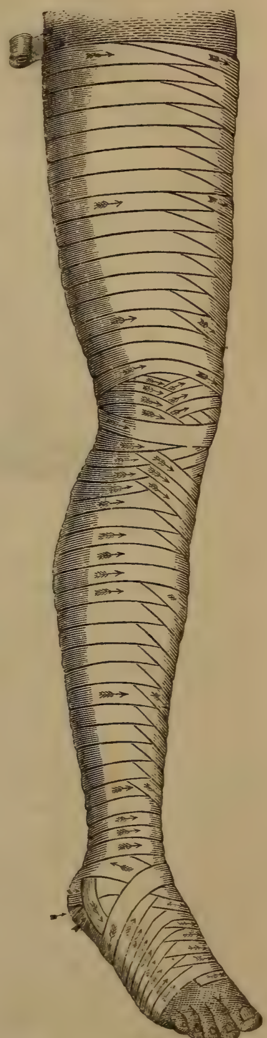
Application.—If it is the right leg, for instance, to which we desire to apply the spiral, proceed exactly in the same manner as we have directed for the spirals of the foot and leg; and in order to cover in the knee, when the spiral of the leg is being finished and the roller arrives at the outer surface of the leg, instead of conducting it circularly around this part, let it have an oblique direction upwards and inwards over the tubercle of the tibia to its inner side, across the posterior aspect of the joint, and around again in front, crossing the previous turn. Execute this movement two or three times, or until the oblique turn, passing from without inwards, is on a level with the

patella; when the roller should be carried across the upper part of the popliteal space, and around the thigh, above the patella, to the inner condyle of the femur. From this point the roller crosses the popliteal space again obliquely upwards and outwards, to pass around the thigh in front to the point of departure, when in crossing the above-named space a third time the roller, passing obliquely downwards and outwards, winds around the outer tuberosity of the tibia, and crosses the previous turn obliquely to the point above the inner condyle of the femur, thus forming a figure of 8 of the knee. Descending, make three or four of these figures of 8 turns until the knee is entirely inclosed; then make one circular turn around the joint over the patella, and gain the thigh which is to be covered in by circular and reverse turns to the hip.

Use.—This beautiful bandage is employed to make a uniform pressure upon the whole extent of the inferior extremity in œdema, ulcers, varicose veins, inflammation, and engorgements of that part; to arrest hemorrhage, and to check the flow of blood in aneurism, and lastly, it is used by some surgeons in fractures of the thigh and leg.

The most attentive care is necessary, during the application of this bandage, that no unnecessary degree of pressure be exerted, or gangrene may be the consequence. Due allowance should also be made for the subsequent swelling of the injured limb.

Fig. 133.



The spiral bandage of the lower extremity.

§ 3. *Figure of* 8 *Bandages.*

The Figure of 8 of a Toe.—The composition and application of this bandage are similar to those of the figure of 8 of the thumb already described. It should be observed, however, that the initial extremity of the roller should be confined around the anterior part of the foot, as in the former case it is secured around the wrist.

Use.—To retain dressings, and make compression upon the toe.

The Figure of 8 of the Foot and Leg. *Composition.*—A roller six yards long and two inches wide.

Application.—Confine the initial extremity two inches above the malleoli by two or three circular turns; and when the roller arrives at the inner aspect of the ankle, conduct it across the dorsum of the foot to the fifth tarso-metatarsal articulation: then pass beneath the sole

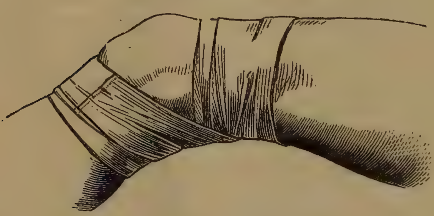
transversely to its inner margin, and make one circular turn around the metatarsus, when the roller should be carried obliquely across the instep to the outer malleolus, and around the posterior surface of the leg to the inner malleolus, thus completing the figure of 8. Go over the same course a second time, and complete the bandage by circular turns around the ankle.

Use.—This bandage may be used to retain dressings upon the ankle, instep, and sole of the foot; but it is generally restricted to making compression upon the internal saphenous vein after venesection at this point.

The Posterior Figure of 8 of the Knee (Fig. 134). *Composition.*—A roller six yards long and two inches wide.

Application.—Confine the initial extremity of the roller three inches above the patella by two or three circular turns around the thigh. Arriving at the external condyle, conduct the roller obliquely across the popliteal space to the inner border of the tibia, and around the anterior surface below its tubercle to the head of the fibula; from this point make one circular turn of the upper portion of the leg, when the roller should be again carried obliquely across the popliteal space to the inner condyle, crossing the previous turn; then around in front of the thigh to the outer condyle, thus completing the figure of 8. Repeat the same manœuvre again, and complete the bandage by circular turns about the lower portion of the thigh.

Fig. 134.



The posterior figure of 8 of the knee.

Use.—To maintain topical applications as poultices, etc. upon the popliteal space, and to make compression upon the popliteal artery, an appropriate compress having been previously placed over that vessel.

The Anterior Figure of 8 of the Knee.—The composition and application of this bandage are similar to those of the posterior figure of 8, only the crosses are to be made over the patella instead of the popliteal space.

Use.—To retain dressings upon the anterior aspect of the knee.

The Figure of 8 of Both Knees. *Composition.*—A roller six yards long and two inches wide.

Application.—Having confined the initial extremity of the roller to the lower part of one of the thighs by circular turns, place the two knees in contact, with a compress between them to prevent their mutual pressure causing excoriation, and then proceed exactly in the same manner as directed for the execution of the figure of 8 of one knee.

Use.—To retain the limbs motionless in fracture of the neck of the femur and after the reduction of dislocation at the hip, and also to approximate the thigh in the healing of a ruptured perineum.

§ 4. *Recurrent Bandages.*

The Recurrent Bandage after Amputation.—The composition and application of the recurrent bandages of the arm and forearm are identical with those of the leg and the thigh now to be described, only the number of reverses are less numerous in consequence of their smaller size.

The Recurrent for the Thigh (after amputation). *Composition.* —A roller twelve yards long and two inches wide.

Application.—Apply the desired dressings upon the end of the stump, and cover them with a Maltese cross; then confine the initial extremity of the roller six or eight inches above the flaps by three or four circular turns; coming to the outer side of the left thigh, for example, reverse the roller and carry it perpendicularly over the end of the stump to its inner side, where another reverse is made to give it a circular direction around the thigh, passing from within outwards, and making two circular turns to confine the reverse. When the roller arrives at the middle of the anterior surface of the thigh, reverse it to make a vertical turn over the centre of the flaps, and, coming to a corresponding point upon its posterior surface, reverse again, and make two circular turns; then cover in by vertical turns, first one side, and then the other of the stump, securing the two reverses of each turn by two circulars.

This recurrent can also be effected with the double-headed roller by placing its body upon some point of the circumference of the limb six or eight inches above the wound; conduct the cylinders around the limb to the opposite side, where they should be crossed; make two circular turns in this manner, and then give one of the heads a vertical direction to make the recurrent turns, which are held by circular turns made with the other head.

Use.—This bandage is employed to retain dressings upon the stump of an amputated limb; that made with the single-headed is more simple but less firm than that executed with the double-headed roller.

The Recurrent of the Hip (after disarticulation). *Composition.*—A roller twelve yards long and two inches wide.

Application.—Confine the initial extremity of the roller around the loins by two or three circular turns; then, arriving at the outer surface of the hip, if it is the right side, make a reverse, and conduct the roller vertically across the wound over the pubis and around the left side to the middle of the right groin, where a reverse is made and a vertical turn carried over the centre of the flaps to the posterior surface of the pelvis; here another reverse becomes necessary, to enable the roller to make two circular turns. Now proceed to cover in, first one side and then the other of the wound, by circular and vertical turns, and finish the bandage by two or three circular turns around the waist.

Use.—To confine dressings upon the hip after disarticulation.

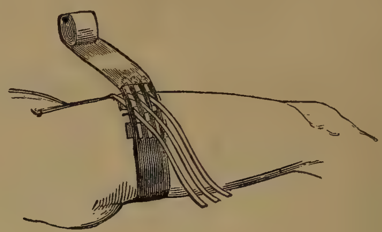
§ 5. *Invaginated Bandages.*

The Uniting Bandage for Vertical Wounds (Figs. 135, 136). *Composition.*—1st. A piece of muslin as wide as the length of the

wound, and long enough to encircle the limb five or six times; split one of its ends into three or more heads, twelve to sixteen inches long,

Fig. 135.

Fig. 136.



Invaginated bandage for vertical wounds.

and at a distance from their base equal to the circumference of the limb, perforate the cloth with a corresponding number of slits. 2d. Two prismatically graduated compresses, somewhat longer than the wound itself, and of a thickness proportional to its depth.

Application.—Place the injured extremity in such a position that the most perfect relaxation of the wounded parts may be obtained; and to prevent engorgement of its lower portion, encircle it with a roller to a level with the injury. Now apply the compresses, one upon each side of the incision, and from one to two inches from it; having placed the body of the bandelette upon a part of the limb exactly opposite to the wound, bring its extremities over the compresses, draw them in opposite directions until the bandage is sufficiently tightened, and terminate with circular turns.

Use.—This uniting bandage was formerly much employed in the treatment of vertical wounds, but the more effectual method with adhesive strips has almost supplanted it. Its use is also restricted from the rarity of wounds exactly vertical.

THE SPIRAL INVAGINATED BANDAGE FOR VERTICAL WOUNDS. *Composition.*—1st. Two graduated compresses. 2d. A band of variable length, proportionate to the volume of the parts, and four fingers wide, wound in two heads.

Application.—To apply the bandage upon a limb, commence by covering it with a spiral from the fingers or toes up to the wound; afterwards apply that portion of the band intermediate to the two cylinders upon that point of the body or of the limb which is opposite to the wound; conduct the two cylinders horizontally over the inferior extremity of the wound, upon each side of which a graduated compress is held by an assistant; make in the band of one of the cylinders a slit that corresponds to the wound, and sufficiently large that the opposite cylinder can pass through it easily; pass the cylinder through this slit in such a manner that the crossing of the bands which results rests over graduated compresses; direct afterwards the two cylinders to the point of departure, ascending a little, and making a circular turn which covers two-thirds of the first one; having

arrived at the point opposite to the wound where you commenced the bandage, simply cross the cylinders, reversing one upon the other; return over the wound, ascending still more, then perforate again the band of one of the cylinders in the same manner, and invaginate them as before; repeat this process until the wound is covered, and terminate the bandage by oblique turns of the neck and axilla, if it is applied upon the arm, and by circulars around the pelvis if to the thigh.

Use.—This bandage was used by M. Gerdy as a substitute for the preceding, believing it to possess more advantages and to be decidedly firmer for a wound eight or ten inches in length.

THE INVAGINATED BANDAGE FOR TRANSVERSE WOUNDS (Fig. 137). *Composition.*—1st. A roller ten yards long and two inches wide. 2d. Two strips of muslin two feet long and of a width corresponding to the breadth of the limb. Split the end of one of these strips into three or four heads a foot long, and perforate the middle of the other with a corresponding number of slits. 3d. Two prismatically graduated compresses.

Fig. 137.

Invaginated bandage for transverse wounds.

Application.—Place the limb in a position most favorable for relaxing the muscles of the parts, and then lay upon its anterior aspect the two bandelettes with their heads and fenestræ regarding each other; then commencing below, secure these by circular and reverse turns ascending towards the trunk. Now arrange the compresses and draw the bandelettes over them in opposite directions, having previously slipped the heads of the one through the slits of the other, when they should be secured by descending spiral turns.

Use.—This bandage has been employed in fracture of the patella, rupture of the tendo-Achilles, and in transverse wounds of the extremities; but it is now rarely used.

B. COMPOUND BANDAGES.

§ 1. T *Bandages.*

THE SINGLE AND DOUBLE T OF THE FOOT. These bandages are prepared and applied in the same manner as the corresponding ones of the hand already described.

Use.—To confine dressings upon the upper and lower aspect of the foot, and also to prevent the union of the toes during cicatrization.

§ 2. *Sling Bandages.*

THE SLING OF THE INSTEP. *Composition.*—A piece of muslin a foot and a half long and three inches and a half wide, split at each end in two tails.

Application.—Place the body of the bandage upon the instep, tie

the inferior tails around the foot and the superior ones around the lower portion of the leg.

Use.—To maintain topical dressings upon the foot.

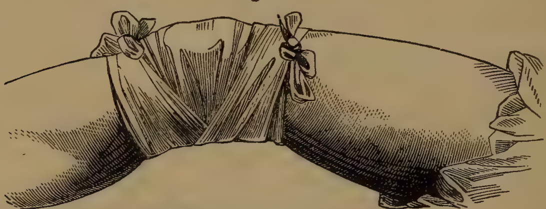
THE SLING OF THE HEEL. *Composition.*—The same as the preceding.

Application.—Place the body of the sling upon the heel, fasten the inferior tails around the forepart of the foot, and the superior ones around the inferior portion of the leg.

Use.—This is a very simple retentive bandage for holding charpie or other dressings to the heel.

THE SLING OF THE KNEE (Fig. 138). *Composition.*—A piece of

Fig. 138.



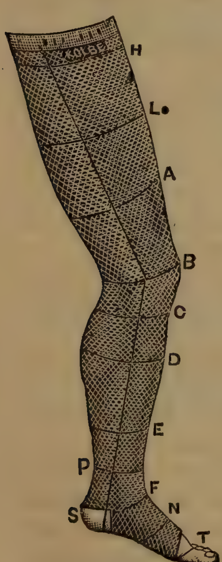
The sling of the knee.

muslin a yard long and a quarter wide, split at each extremity in two tails.

Application.—Lay the body of the sling over the patella, or popliteal space, tie the superior extremities around the inferior part of the thigh, and the inferior ones around the superior portion of the leg.

Use.—To maintain dressings upon the knee.

Fig. 139.



Laced bandage.

§ 3. *Sheath Bandages.*

THE SHEATH BANDAGE FOR THE TOE.—This bandage is prepared and applied in the same manner as the sheath for the finger.

Use.—This is a convenient manner of retaining dressings upon the toes.

§ 4. *Laced Bandages.*

THE LACED AND ELASTIC BANDAGES OF THE FOOT AND LEG (Fig. 139).—These bandages were formerly most frequently made of cotton or woollen cloth, kid, buckskin, or silk, with eyelet holes in their lateral margins, through which a long lacing cord passed, and by means of which they could be closely applied to the limb. At present India-rubber in some of its forms is much more commonly employed in their manufacture, and the use of the cord done away with. The bandage seen in Fig. 139 is thus prepared; the letters indicate the position of the lines of measurement for making the bandage by.

Use.—To make uniform compression of the lower extremities in varicose dilatation of the veins, sprains of the ankle and knee, in cases of loose cartilages in the latter joint, and when the patella is readily disposed to luxation.

C. Mayor's Bandages for the Lower Extremities.

The Cravat, Triangle, Square Muslin and Handkerchief may often be advantageously had recourse to in various injuries of the thigh, leg, foot, and toes; their application is simple, and needs no special notice here.

Imbricated Squares and Cravats.—These are recommended by Mayor as substitutes for the spiral bandage of the lower extremity, and the bandage of Scultetus. Their composition and application are obvious.

The Tibial Triangle. *Composition.*—A triangular piece of muslin a yard long and sixteen inches from the base to its apex.

Application.—Place the middle of the base crosswise beneath the patella, conduct one of the lateral angles around the calf of the leg, and pin it at the upper part of the bandage; the other angle should be carried in the opposite direction around the calf, and fastened over the lower aspect of the leg. The apex is now to be drawn around the calf, and pinned to the centre of the triangle over the tibia.

Use.—This bandage may be conveniently used for retaining dressings upon the leg, such as blisters and poultices, &c.

The Popliteal Cravat. *Composition.*—A cravat a yard long.

Application.—Place the middle of the cravat above the popliteal space, conduct the two ends forward, cross them over the patella and again over the popliteal space, and finally draw them forwards and tie or pin them together over the tibia.

Use.—Employed in those cases in which the posterior figure of 8 of the knee is indicated.

The Tarso-Patellar Cravats. *Composition.*—Three cravats, each a yard long.

Application.—Tie one of the cravats loosely around the tarsus, place the base of another one upon the front of the thigh above the patella, cross its extremities over the popliteal space and fasten them together below the knee in front. The middle of the third cravat should loop around the tarsal cravat, and its extremities be carried up under the upper cravat, one upon each side, and then reflected upon themselves and pinned.

Use.—This bandage is used in fractures of the patella, and in transverse wounds of the anterior surface of the ankle.

The Compound Metatarso-Patellar Cravats. *Composition.*—1st. Five cravats, each a yard long. 2d. A paste-board gutter splint.

Application.—Arrange three of the cravats in the same manner as directed in the tarso-patellar cravats, and raise the limb somewhat above the plane of the back, by placing a pillow under it; let the gutter splint be now applied beneath the knee and fastened with the remaining cravats to the limb, one encircling the leg and the other the thigh.

Use.—In fractures of the patella. It is much more firm and efficient than the preceding bandage, and should always take the precedence of it in the treatment of this fracture.

THE TARSO-PELVIC AND TARSO-CRURAL CRAVATS. *Composition.*—Three cravats each a yard long.

Application.—Fasten one of the cravats around the tarsus, a second around the pelvis; then bend the leg upon the thigh and forcibly extend the foot upon the leg; and loop the middle of the third cravat around the lower one, over the sole of the foot: carry its extremities upwards under the pelvic cravat and knot them together. The other cravat may be fastened around the upper part of the thigh (tarso-crural); but this modification is less advantageous or efficient than the tarso-pelvic cravats.

Use.—To flex the leg in transverse wounds of the posterior aspect and popliteal space, and to extend the foot in rupture of the tendo-Achilles.

THE TRIANGULAR CAP FOR STUMPS. *Composition.*—A triangle one yard long and sixteen inches from base to apex.

Application.—Place the base of the triangle upon the anterior surface of the stump, conduct its extremities posteriorly, cross them behind, and bring them forwards and knot together in front; reflect the apex over the wound, and pin it over the centre of the bandage.

Use.—With this triangle a stump of any limb may be conveniently and quickly dressed. The cap may be prevented from slipping off by sewing two strips to its base and fastening them around the joint above, or in the case of the thigh and arm around the pelvis and neck.

THE TRIANGULAR CAP FOR THE HEEL. *Composition.*—A triangle a foot and a half long and ten inches high.

Application.—Place the base of the triangle under the heel, conduct its lateral angles around the instep and the lower portion of the leg, and tie them together over the tendo-Achilles; turn the apex upwards over the heel and fasten it to the bandage behind.

Use.—Employed as a retentive bandage for the heel.

THE METATARSO-MALLEOLAR CRAVAT. *Composition.*—A cravat two feet long.

Application.—Place the middle of the cravat obliquely across the instep, carry the higher extremity around the ankle, and lower one under the sole of the foot to the dorsum, where the ends should be tied together.

Use.—A simple retentive bandage for dressings tied over the instep.

THE MALLEOLAR PHALANGEAL TRIANGLE. *Composition.*—A triangle a couple of feet long and a foot deep.

Application.—Place the middle of the base of the triangle under the instep, reflect its apex over the toes to the dorsum of the foot, then conduct the lateral angles up over the instep, cross them to go behind the lower portion of the leg upon each side, and cross them there; finally bring them forwards and pin them together over the top of the foot.

Use.—This triangle incloses the whole foot, and will serve an excellent purpose for retaining dressings upon any part of it.

THE TIBIO-CERVICAL CRAVATS. *Composition.*—1st. A cravat two yards long. 2d. A triangle a yard long and two feet deep.

Application.—Apply the base of the cravat upon the shoulder of the sound side, conduct its extremities obliquely across the chest and tie them together upon the opposite hip; then bend the leg at right angles, and glide the base of the triangle under the knee as far as the lower portion of the leg, where the lateral angles are carried upwards and fastened to the cravat; the apex is folded round the lower and front face of the thigh and pinned upon the outer side of the leg.

Use.—To support the leg after fractures or sprains, when either the patient desires, or the surgeon deems it necessary for him to move about upon a crutch, an important advantage in forwarding the convalescence of a patient in bad health affected with a fracture.

THE UNITING CORDS FOR LONGITUDINAL WOUNDS.—Mayor, in longitudinal wounds of the extremities, employs an arrangement similar to his uniting bandage for harelip: it requires no special description in this place. In transverse wounds, he depends upon position simply for the approximation of their edges.

D. RIGAL'S BANDAGES FOR THE LOWER EXTREMITIES.

THE TRIANGLE FOR THE TROCHANTER MAJOR. *Composition.*—A square piece of muslin folded in a triangle.

Application.—Place the base of the triangle over the right or the left hip, conduct its extremities around the body, and tie them upon the opposite side; then draw the apex downwards, separate its two angles, and carry them around the thigh, one in front, the other behind, to be fastened together upon its inner aspect.

Use.—The same as Mayor's cap for the hip.

THE BANDAGE OF THE LEG. *Composition.*—A square piece of muslin folded in a triangle.

Application.—Place the base of the triangle upon the leg below the knee, conduct its extremities around it and tie them together; then draw down its apex around the leg, separate its two angles and tie them around the ankle.

THE BANDAGE FOR THE FOOT.—This bandage is applied in the same manner as the cap for the foot.

PART II.

MECHANICAL BANDAGES AND APPARATUS.

We have now considered the more simple and frequently employed bandages in surgical practice, and, to continue this sketch of what may be called the mechanics of surgery, we shall devote a few pages to those more complicated mechanisms had recourse to in the treatment of the various forms of deformities and deficiencies to which the human body is liable at all times, and generally designated as mechanical or orthopædic bandages or apparatus. Although they have not had that amount of careful study and attention given them by the profession which their real importance would seem rigorously to demand, yet it must not be supposed on that account that they are of little value. On the contrary, if one reflects upon the subject for a moment, and learns that there are thousands of cases of various kinds of deformities in our country, particularly in our large cities, which are remediable in their earlier stages by the use of properly constructed mechanical appliances alone, and even when further advanced, can be much benefited by them; or, again, that there is yet another and large class of such affections in which, after an appropriate and timely use of the knife in dividing tendons and ligamentous bands, the subsequent application of mechanical contrivances will materially hasten a speedy and successful issue; he can then form some estimate both of their importance and the range of their application.

In all cases of deformities, however, we should be fully admonished that it is in their earlier stages—in childhood, indeed—when important and permanent success can be secured; and hence, how important a duty it is for the medical practitioner to familiarize himself with the subject of orthopraxy, to recognize the earliest manifestations of an impending deformity, so that he may be able, when the opportunity presents itself, to rescue a patient from the deplorable fate of a wretched cripple or from an unseemly deformity.

CHAPTER I.

APPARATUS FOR REMEDYING THE LOSS OF PARTS.

SECTION I.

LOSS OF PARTS OF THE HEAD AND NECK.

Deficiency of the Cranial Walls.—From injury or operations performed upon the skull, more or less of its bony walls may have been destroyed. In the first instance the loss may amount to several square inches, as is observed sometimes in sabre and gunshot wounds, where the brain and its membrane, being exposed, may be seen to rise and fall with every pulsation of the heart. In the operation of trephining, generally a small perforation of the bone only is made, and scarcely requires any surgical interference.

The natural mode of cure, in such cases, is the effusion of plastic matter into the excavation, and its organization in a tough, strong, and fibrous membrane or fibro-cartilage, which, stretching from the edges of the bone all around, closes the opening and defends the brain from exterior violence. This membrane becomes sometimes ossified, and establishes a more effectual barrier against exterior hurtful influences.

In those cases where the efforts of nature do not succeed to a sufficient extent to protect the parts beneath, either from some defect in the recuperative powers or from the extent of the injury, some mechanical contrivance becomes necessary. An extremely simple one consists of a metallic or gutta-percha plate, of sufficient size to cover the opening and rest upon its margins, and of either a flat or a slightly concavo-convex shape, according to the circumstances of the case, and painted in imitation of the scalp.

There are three modes of retaining it in its proper situation. 1st. By strings affixed to its margins and colored to match the hair, and tied under the chin. 2d. The plate may have its edges perforated with numerous holes, by means of which it can be sewed to the margins of a hole of corresponding size, cut in a skull cap of muslin or other material, and placed in such a manner that when the cap is upon the head the plate will fit exactly over the injury. 3d. The last and most elegant plan is to solder two slender springs to the plate, which, spanning the vault of the cranium, pass, concealed under the hair, to points situated above the ears, where they are provided with two little pads. Should the defect be upon one side, one spring will often support the plate sufficiently firm by taking its *point d'appui* above the ear of the opposite side.

As already stated, this plate is intended to protect the brain after the loss of parts of its natural bony defensive walls.

Deficiency of the Integuments.—It is occasionally necessary to

deprive a part of its integuments for a longer or shorter time, as occurs in establishing issues by the actual or potential cautery.

The back of the neck is often selected as the point at which the derivation is established in diseases of the brain. An open issue, intended to be maintained for a long time, having been made, in order to shield it from the irritating contact of exterior agents, as the stiff hair upon the back of the head, and the clothes, a metallic or gutta-percha plate should be prepared as in the former instance, slightly concavo-convex, and either fastened to the neck by two strings tying in front, or set in the middle of a common cravat, when the issue will be entirely concealed.

A similar plate may be prepared for any other portion of the body.

Deficiency of the Nose.—The nose may be partially or entirely destroyed by injury or disease; and plastic surgery has accomplished remarkable results in restoring the lost parts by the various processes of rhinoplasty; yet there are numerous cases where it completely fails, or the patient is unwilling to undergo any operation; and these are the cases for which mechanical surgery can do much in providing an artificial substitute.

The nasal organ should be completely healed before any mechanical contrivance is placed upon it intended to correct the deformity, to restore timbre to the voice, and to protect the nares from irritating particles floating in the air which may produce chronic inflammation and even ulcerations of its lining membrane.

Artificial noses were formerly constructed of linden or willow wood, metallic plates, and papier maché, but the lightness, indestructibility, and plasticity of gutta-percha commend it highly for this purpose.

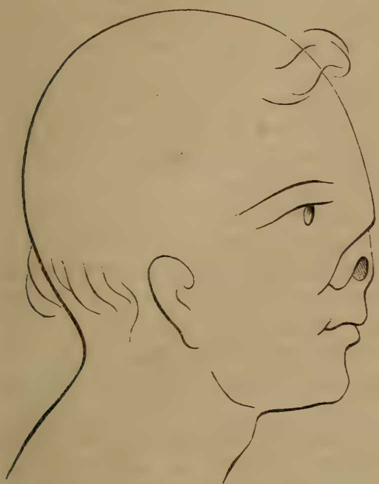
The artificial nose should be made of comely shape, in fair proportion with the symmetry of the countenance, and artistically colored.

To maintain it in place, affix to its posterior edges two or three little springs, which may catch upon the inner surface of the nasal fissure, or solder a long spring to the apex of the artificial nose, ascending between the eyes and spanning the cranium, to terminate at the occiput, where it takes its *point d'appui* by means of a little pad. Should the patient wear glasses, the top of the nose may be attached to the bow arching across from eye to eye.

Sometimes a small portion only of this organ is destroyed, in which case the substituted member should exactly resemble it, and may be held in place by narrow strips of adhesive or isinglass plaster stretching over the cheek and side of the nose. This of course would be a very troublesome plan, and it was to remedy this that Mr. S. Snell invented the nose sketched below (*Medico-Chirurgical Review*, vol. iii., 1825), and successfully applied it in the case of an army officer who had lost the greater part of his nose (Fig. 140). He thus describes the method of making it: "A correct model was first taken of the defective parts, which was cast in brass, and upon which a thin gold plate was accurately fitted, in the manner generally adopted by jewellers. To the inner surface of this plate, at that part which was to form the septum, were soldered three pieces of gold wire, which terminated, each, by a small flat plate, perforated with holes, for the purpose of sewing

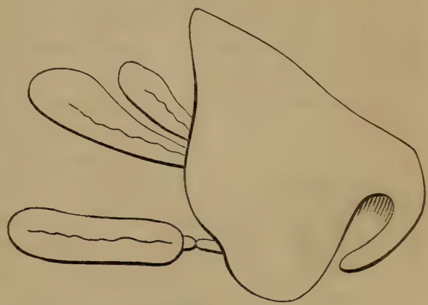
to its outer surface a covering of India-rubber. These gold wires were rendered highly elastic (Fig. 141).

Fig. 140.



The appearance of the face before the artificial nose was attached.

Fig. 141.



The artificial nose.

"Upon the outer side of the principal plate was next fitted a piece of ivory, so as entirely to cover it; the extreme edges of the ivory being intended to come in close contact with the face. The ivory was then carved to the exact shape and fashion of such a nose as appeared most likely to be suitable for the size and contour of the face for which it was intended—the under part being hollowed out to form the nostrils, rendering it very light and thin. The gold and bone were now riveted to each other firmly by small gold pins. The artificial nose was then placed upon the face, and an artist colored it in oil, so as to resemble the surrounding parts, both in color and character.

Fig. 142.

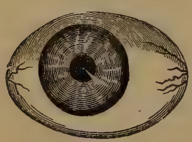
The appearance of the face with the nose attached.

The nose was held in its position upon the face by three elastic wires (Fig. 142); the two lower ones, having a tendency to press outwards during confinement, pressed against the lateral walls of the nasal cavity. The upper spring having a similar tendency, pressed against the upper roof of the same cavity. The India-rubber was used for the purpose of defending the parts from the effects of pressure of the springs."

Gutta-percha may be modelled in the same manner, and will afford a lighter and cheaper nose.

Deficiency of the Eye.—When from injury or disease the front of the globe of the eye is destroyed or its contents evacuated, it is very desirable to remedy the deformity which is thereby caused; for this purpose an elegant prosthetic substitute is made use of, called the artificial eye (Fig. 143). The art of manufacturing it was practised at an early period, and two kinds were employed made of steel plates. The first covered the whole eye, and had eyelids, irides, &c., painted upon its outer surface, and was held in place by steel springs; the second resembled the eye now in common use.

Fig. 143.



Artificial eye.

Porcelain and glass are the materials of which the artist avails himself at present for making artificial eyes; they are sections of spheres of different diameters for adaptation to orbits of varying size in different persons. Each case requiring some special shape, according to the extent of injury or loss of the orbital contents.

Considerable taste may be displayed in the selection of an appropriate eye, as to the color of the iris, and the convexity of the cornea, to correspond with the remaining organ. The selection should be made from a large number, and judgment as to perfect adaptability in all respects above mentioned should be given by a person of experience and taste. Another still more important point, as regards the comfort of the patient, is to obtain an article with perfectly smooth edges, as a very slight degree of roughness may cause irritation, or even inflammation of the parts.

Should the remnant of the globe have the insertions of the orbital muscles still intact, the artificial eye fitted to its anterior surface will participate to some extent in its motions, and so closely resemble the healthy organ as to render detection of the substitute very difficult, if not impossible. On the other hand, when the contents of the orbit are wholly evacuated the eye will not possess any motion, and its vacant and fixed stare and want of life-like brilliancy, as compared with the natural organ, will often give the countenance a disagreeable expression. The introduction of the eye should not be attempted until cicatrization is completed and all tenderness of the parts gone; its insertion may then be effected by taking hold of the outer angle of the eye with the thumb and index finger of the right hand, after dipping it in water, or a thin solution of mucilage, and placing its upper edge gently under the superior lid, which has been raised previously by the index finger of the left hand, and permitted to close upon the outer surface of the eye; the lower lid is now to be depressed to receive its inferior border. The pressure of the two lids will effectually retain the eye in its proper site.

The eye, at first, should be worn only three or four hours at a time, until the parts become accustomed to its presence. At night it should be removed and kept in a glass of fresh water, which will prevent mucosity concreting upon its surface.

The plan of removing the eye when necessary is very simple. The

lower lid is depressed, and the head of a pin is inserted beneath its edge and the eye drawn forwards.

In some cases, with the very best and appropriate eye, so much irritation is caused that the patient has to abandon its use permanently.

Deficiency of the Ear.—For the replacement of a lost or mutilated ear, a substitute may be prepared either of gutta-percha or of gold.

In the first case, a cast of plaster of Paris should be made of the sound ear, and from this a metallic matrix or mould is prepared, into which the melted India-rubber is poured; and when hardened, is vulcanized and then painted to imitate the natural organ. Should it be decided to have a gold ear, two models are made, one of the anterior surface of the ear, and the other of its posterior surface. Then fit two thin gold plates upon these, and when the proper shapes have been attained, remove them from the models and solder their edges together.

In both instances the ear is attached to the side of the head by a short tube upon its back fitting into the meatus, and held in place by a fine spring encircling the top of the head.

Deficiency of the Cheeks and Lips.—Very often, for the destruction of parts of the cheeks and lips from gunshot wounds, lupus, or other causes, an artificial substitute can be easily made, which, when carefully fitted to the parts and painted flesh color, not only conceals the deformity, but prevents the escape of the saliva upon the face.

The details of the process will, of course, vary according to the nature and extent of the parts destroyed, but the principle of constructing substitutes for them is the same. First prepare a model of plaster of the lost portion; from this are made analogous shapes of gutta-percha or metallic plates, and if necessary, the saliva may be received in a little gutta-percha pouch, concealed under the cravat, and connected by a tube of India-rubber with the substitute over the buccal cavity.

In extensive disease of the upper maxillary bone requiring an artificial palate, these plates, resembling parts of the cheek which they are designed to replace, may be connected with the palate by little metallic arms.

Deficiency of the Palate.—The loss of portions of the palate is commonly due to two sources. Its absence may be owing to a congenital defect, constituting Wolf's jaw, or it may be destroyed by certain diseases, especially those of a syphilitic nature, and lupus.

The defect may be confined to the hard palate or extend to the velum, so that the natural boundary walls between the nasal and buccal cavities are entirely removed by the ulcerative process. In still more serious cases, the alveolar process and the body of the superior maxillary bone itself may be involved to a greater or less extent.

The recuperative resources of the system are sometimes displayed in a wonderful manner by effecting the closing of this palatal fissure. This should teach us to avoid all kinds of surgical interference in such cases, except the occasional use of caustic, until it is certain that the defect is likely to be permanent. Appeal is then had to an operation which is often crowned with signal success; yet there remain many

cases not amenable to the treatment with the knife; and in these, properly constructed, mechanical appliances answer frequently in alleviating the sufferings and annoyances of the patient.

In a moderate fissure of the hard palate in young subjects, the approximation of its edges may sometimes be effected by a very simple and ingenious plan. Construct a palatal plate of gold with three clasps upon each side to catch upon the teeth, then remove a slip along its centre and replace it by a piece of India-rubber, which, when the clasps are in place, by its tension, will insensibly draw the sides of the jaw together.

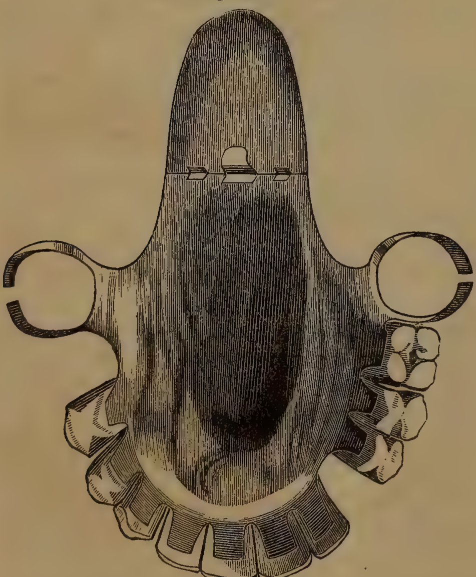
When all means instituted to obliterate the fissure fail, recourse must be had to mechanical occlusion; the agents used for this purpose are called obturators.

One of the simplest and oldest forms of an obturator is that invented by Ambrose Paré in 1585. It consists of a metallic plate, generally silver, with a piece of sponge attached to one of its sides and intended to be introduced through the opening in the palate into the nasal cavity. The absorption of moisture swells the sponge, closes the aperture, and effectually retains the plate against the palatal vault. This obturator is easily arranged, and only requires removal two or three times a day to be cleansed from adhering mucosities.

A modification of this is to solder to the upper surface of the plate, in place of the sponge, a revolving tenon bearing at its apex wing-like appendages, which are intended to support the plate by catching upon the floor of the nares.

All of those instruments which depend upon the pressure exercised by them upon the surrounding parts for support have the disadvantage of still further enlarg- the orifice in which they are placed.

Fig. 144.



Artificial palate fastening by clasps.

To avoid this disadvantage, and at the same time to prevent the secretions collecting in the little pit formed by the upper surface of the plate and the edges of the fissure, a drum, of the exact size of the opening and sufficiently deep to render the floor of the nares flush, is soldered to the plate, which is held in its proper situation by clasps catching upon the teeth.

When the alveolar process is destroyed and the cavities of the antrum and the mouth communicate, the plates should be made

larger, and possess a projecting rim upon which any artificial teeth needed may be fastened. (Fig. 144.)

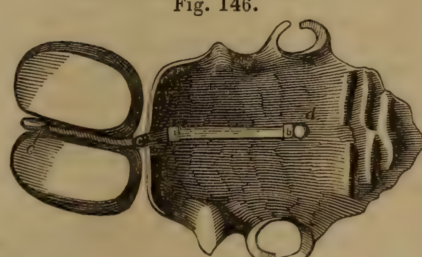
The loss of the velum is a more serious concern, as regards the facility of procuring an effective mechanical apparatus, yet the greatest ingenuity has been displayed by mechanicians in supplying a substitute, and fortunately not without some success. It would be useless to follow the detail of, or even to mention, the numerous obturators invented since M. Delabarre, of Paris, first introduced his into notice, of which the former are for the most part modifications.

It will be proper, therefore, only to describe, in order to give the reader an idea of what may be done in the way of a prosthetic substitution for the velum and uvula, one of the best obturators. There is no doubt but that all the benefit which is possible to be derived from an appliance of this sort may, in a majority of cases, be secured by the artificial palate and uvula of Dr. Hullihen. It consists of: "1st. A valve, made of gold plate, as thin as it can well be worked; 2d. A spiral spring, about an inch long, and of the size usually made for whole sets of teeth; 3d. A slider, one inch and a half in length, and of the width and thickness of a common watch-spring; 4th. A plate, larger or smaller, as the case may require, stuck up in the usual way, to fit the roof of the mouth. The size and form of the valve are obtained by taking an impression of the posterior opening of the nares: the plate composing it should be stuck up in two parts, front and back, which, when soldered together, makes a hollow body of the form in Fig. 145, letter *a*. At the upper end of the valve a small pin is soldered, the point of which looks downwards, and of sufficient thickness to fit very tightly in one end of the spiral spring. The spiral spring must be made of such a length as will permit the valve to rest slightly upon the upper surface of the remnants of the lost velum. The slider has a pin in the posterior end, looking upwards to receive the other end of the spiral spring, before described. The anterior end of the slider has a small button looking downwards; the slider is attached to the plate by two small clasps, as represented in Fig. 146, *b*, *b*. The plate may be made to cover the entire roof of the mouth, when necessary; or it may be made only sufficiently large to permit the mounting of the slider. These different plates, when put together, particularly if the plate

Fig. 145.

Hullihen's artificial palate and uvula. Upper view.

Fig. 146.



The same. Lower view.

is to cover the whole roof of the mouth, make a plate of the form represented in Fig. 145.

"Fig. 146 shows the attachment of the spiral spring to the valve and slider, *c, c*. The staples confine the slider to the plate, *b, b*—and the button on the end of the slider, *d*, by which the valve may be set back or forward, as desired by the patient, without removing the plate from the mouth.

"Thus it will be perceived that the peculiarities of this plate are: First, a valve to fit to the posterior opening of the nares. Secondly, the attachment of this valve to a slider, by which the patient is enabled to adjust the valve while in the mouth, in such a way as to admit through the nares just the quantity of air desired. Thirdly, the mounting of the valve on a spiral spring, which will permit it to vibrate backwards and forwards, as the breath is inhaled or exhaled; and also to be moved by any muscular action that may remain in the remnants of the lost velum, thereby answering, to a great extent, the purposes of a velum."

Deficiency of the Chin.—Some of the most remarkable cases of loss of the chin and inferior maxillary bone are recorded in the *Dictionnaire des Sciences Médicales* and the *Bulletin de l'Académie de Médecine* of the pensioners in the Hôtel des Invalides, at Paris, wounded in the campaigns of Napoleon.

Hutin gives an account of a soldier by the name of Frenais, who was wounded, in 1811, at the battle of Albufera, by a shot which carried away the chin. This man died in 1850, and there was observed no trace of an inferior maxillary bone until the finger was introduced behind the palatal process, when the remnants of the ascending rami of the inferior maxillary could be felt; the tongue was thicker than natural, and retracted upon the os hyoides to the extent of a third of its length; the deglutition was easy, but articulation was impossible without the assistance of the mask which he wore.

H. Larrey reports a somewhat similar case: the soldier was wounded at the siege of the citadel of Antwerp, in 1832. He could articulate the vowels easily, but the consonants with difficulty, and required to be fed with a vessel having a long spout; the saliva escaped externally in large quantities, yet did not interfere with his nutrition. The deformity was concealed by a mask. There are other cases of like character reported.

The most that can be done for the unfortunates who are wounded in this manner is to conceal their disgusting disfigurement by a mask made of metal or vulcanized rubber, obtained from an exact model of the countenance, and resembling in shape the outline of the lower parts of the face, and properly painted. The apparatus may be held in place by springs or straps encircling the head.

Deficiency of the Teeth.—The manner of manufacturing and fitting teeth devolves upon the dentist, and therefore requires no notice here.

SECTION II.

APPARATUS FOR REMEDYING THE DEFICIENCIES OF THE TRUNK.

Deficiencies of the Thoracic Walls.—Deficiency of the thoracic walls is exceedingly rare, and always the result of congenital defect; in those cases which have been observed, the defect was in the sternum, a greater or less extent of which never having been developed, the motions of the organs below were exposed to view, affording a rare opportunity for the observation and study of the physiologist.

In such cases, if it should be demanded, the construction and application of a defensive shield would be simple, as protection to the parts beneath is the desideratum. A plate of metal or other suitable light and hard material, slightly convex anteriorly and held upon the chest by straps or springs, or what would be still more secure, fastened by its margins to the edges of a perforation in a tightly fitting jacket, would answer perfectly.

Deficiency of the Abdominal Walls.—Loss of substance of the abdominal walls is rare, yet more common than the similar condition of the chest.

It may be the result of congenital defect or injury, the extent of the deficiency being always more considerable in the former case. The case of the man who was in the habit of exhibiting himself annually before the medical classes of the different colleges is well known to many professional gentlemen who saw him. In this person the entire wall of the abdomen in the hypogastric region was absent, as well as the corresponding portion of the bladder, whose surface was exposed, its mucous membrane and the entrance of the ureters being in prominent view. I have seen two other persons similarly affected.

The mechanical apparatus for such a case is also simple, consisting of a mask, or cap of metal or vulcanite, with an India-rubber bag affixed to its lower borders to receive the urine as it dribbles away, fitting over the pubis and hypogastrium, and secured to the body by straps, springs, or by an abdominal bandage to a perforation in which the cap is fastened by its margins.

I have seen four cases of wounds of the abdomen, resulting from stabs, in which the tendon of the external oblique muscle never healed, the aperture being covered with a thin cicatrix which yielded to the weight of the bowels when the patients were in the upright position and allowed their protrusion.

One of the patients was rendered comfortable by having a truss applied with a broad flat pad upon its anterior extremity which pressed upon the aperture; one was operated upon by a surgeon who inserted a suture in the margins of the fissure after the skin was cut through; the patient, after a narrow escape with his life, was not benefited. The other two passed from under my notice without anything having been done.

The celebrated case of Alexis St. Martin is well known, and the mechanical appliance that would have been proper for him is evident.

Deficiency of the Walls of the Spinal Canal.—In the development of the vertebræ, ossification in the bodies begins at the extremities of the spinal column and advances towards its middle, so that defect in them from arrested growth would be found in the dorsal region, while the laminæ are ossified from the middle of the spinal column towards its extremities, so that imperfect development of the spinal canal is found in the cervical and lumbar region, and more often in the latter. This is denominated spina-bifida, or hydrorachitis.

The membranes of the cord, not being supported, bulge externally and form an elastic tumor, varying in size from a pigeon's egg to an orange, or even larger, filled with the synovia-like fluid commonly contained in the spinal canal.

This disease is congenital, and the only surgical interference proper, or at least likely to be attended with success, is compression by means of a properly constructed instrument resembling a truss, and furnished at one of its extremities with a padded metallic disk which will permit an accurate and uniform pressure to be exercised over the whole surface of the tumor.

SECTION III.

APPARATUS FOR REMEDYING DEFICIENCIES OF THE UPPER EXTREMITIES.

Deficiency of the Arm.—It is not intended, under this head, to give any lengthened account of the history and construction of artificial arms, although the subject is one of considerable interest and utility to military surgeons, and to practitioners in the country. Inasmuch as they are often consulted upon the selection of a proper prosthetic substitute, it may be of essential service for them to know the proper method of taking appropriate measurements for the artist to work by in turning out a nicely fitting limb, and of its construction and application. An additional reason for their acquiring some information in respect to this matter is, that they may contribute considerably to a patient's interest and comfort, by taking advantage of opportunities, sometimes offered, of obtaining that length of stump best suited for the adaptation of the most effective and useful mechanical contrivance.

It is an interesting fact that the first effort made to provide artificial limbs, of which we have any accurate account, was by Ambrose Paré, surgeon, successively to Henry II., Charles IX., and Henry IV. of France. In his works, published about the middle of the sixteenth century, he describes an artificial arm, which was made for him "to his great cost and charges, by a most ingenious and excellent smith, dwelling at Paris, who is called, of those who knew him, and also of strangers, by no other name than the little Lorrain."—*Les Œuvres d'Ambrose Paré,* p. 677.

The framework of the arm was constructed of sheet-iron, with appropriate springs in its interior for moving the fingers, wrist, and elbow, and was, therefore, very heavy, so that but few could wear it for a long period continuously.

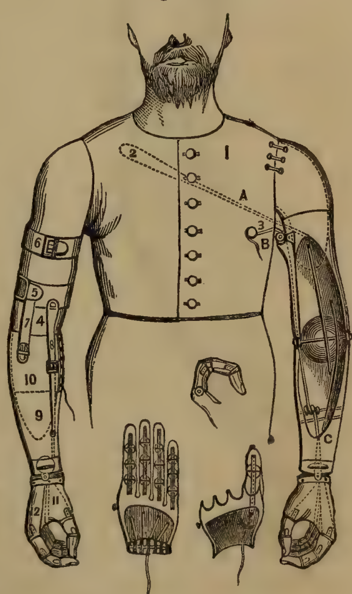
This arm, though not comparable to the artistic productions of the present day, redounds much to the ingenuity and humanity of the

great French surgeon, who was always nobly striving to alleviate the misfortunes and ills of mankind, by the invention of new, or more improved apparatus, and surgical processes.

Gotz von Berlichingen, of Nuremberg, invented an arm and hand made of iron, similar in mechanism to that of Paré, but much lighter, and so far, was a positive improvement. Beyond this, little progress was made until 1812, when Mr. Bailiff, of Berlin, happily constructed an arm and hand, weighing nearly a pound, which could seize upon small objects with fingers put in action by concealed gut cords fastened to the phalanges below, and connected above by a cord to the upper border of the sheath, and by the tension of which the fingers were moved by overcoming the resistance of small springs placed upon their palmar aspects.

In 1845, Van Peterson, of Berlin, surpassed all his predecessors in producing an artificial limb of extraordinary ingenuity, and was the subject of a report of a commission of the Academy of Sciences, Paris, composed of Velpeau, Rayer, Magendie, and Gambey. These gentlemen selected for experiment an old soldier who had lost both arms, and upon whom the artificial limbs of Peterson were placed as seen in Fig 147.

Fig. 147.



Van Peterson's artificial arm.

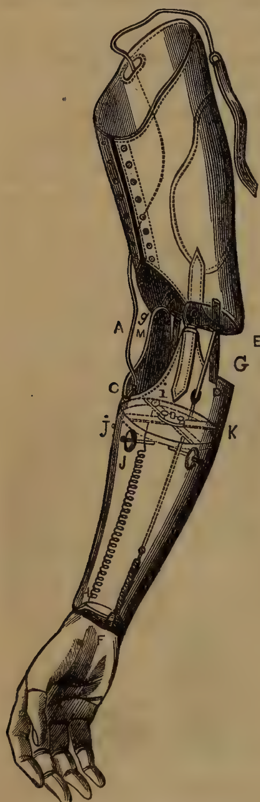
The mechanism of motion consists of gut cords, which are fixed above to a corset, and below to the front of the forearm and to the dorsal aspect of the fingers, each of the latter possessing three articulated phalanges, and held in apposition by their points with the tip of the thumb by springs. When the person moves his stump forwards, the cord A, passing between the corset and forearm, being made tense, draws the latter up, and flexes it upon the arm, by which movement the hand may be carried to the mouth; backward movement of the stump extends the arm again. The cord B is attached to the corset at the point marked 3, and, passing around a pulley in the forearm, is connected with the extending cords of the fingers, in such a manner that when the stump is abducted it draws upon the fingers and extends them, which immediately resume, by means of the springs placed upon their palmar surfaces, their original position of apposition with the thumb by approximating the stump to the chest.

The motions of the natural limb were still further imitated by Charrière, of Paris, under the direction of M. Huguier. As seen in the figure (Fig. 148), this apparatus consists of a laced armlet articulated with a forearm of stiff leather composed of two sections, the

latter being also movably articulated with a carved, hollow wooden hand, provided with fingers made of steel and covered with wood, and sufficiently firm to retain the position in which they are placed.

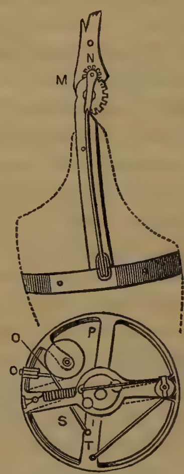
The armlet intended to embrace the stump is fastened above to a corset or shoulder-cap. Motion is impressed upon the limb by the movements of the stump acting upon a catgut cord taking a fixed point above the shoulder-cap, and attached below to the forearm. By abducting the stump, the cord A flexes the forearm, and through this movement the wrist also by means of the cord D extending between the eccentric projecting posteriorly, from the inner hinge of the elbow, and

Fig. 148.



Artificial arm of Charrière.

Fig. 149.



Mechanism of pronation of Charrière's artificial arm.

the anterior margin of the hand, into which it is inserted at F by means of a short spiral spring. When the stump again resumes its position by the side of the chest, and the cords A and D are relaxed, the elastic bands G extend the forearm, and at the same moment the spiral spring extending between the points I and H causes the hand to execute the same movement. By pressing upon one of the projections J, with the other hand or hip, the movements of pronation and supination may be impressed upon the limb. There is also another provision made for these motions by a mechanism attached to the external hinge of the elbow at M, Fig. 149; it consists in an eccentric, N, moved by a sectional cog-wheel, M, that it may be made to complete one whole revolution by the complete flexion of the forearm; to the end of this eccentric the cord O is fastened above, and, passing downwards, enters an aperture in the forearm, goes around the pulley P, and finally is terminated by being attached to one of the cross-bars of the forearm at the point T, so that when the forearm has executed half the movement

of flexion the eccentric also completes half a revolution, and ascends to a position parallel with the arm, drawing the cord O to its extreme degree of tension, and necessarily supinating the forearm. The flexion being still further increased, the eccentric descends towards its original position, relaxing the cord O, and permits the spiral spring S, passing around the pulley B and attached to the cross-bar at T, to bring the arm into pronation again. In extension of the limb, again, the eccentric first supinates and then pronates the forearm as before. By the same mechanism extension of the fingers may be produced.

Another artificial limb, equalling the preceding in ingenuity, was invented by M. Bechard, and is thus described by Bigg:—

"The point of support is a laced sheath carried by two iron splints adapted to the arm. The articulation of the elbow presents nothing particular. The forearm and hand consist of three movable pieces of hollow wood.

"1st. The upper portion is fixed by means of the two splints which serve for the articulation of the elbow and terminate there. 2d. The second portion, entirely of wood, corresponds to the lower two-thirds of the whole length; it carries at its upper part a movable chariot, rolling by means of bone castors which slide on a circular plate of iron, so that the movements are very smooth. This arrangement allows this portion to move on the upper one through a quarter of a circle, and this motion, being transmitted to the whole lower part, simulates the rotation of the limb outwards.

"The limb is maintained in the normal state of pronation by a spiral spring fixed at the top of the piece in the centre of the chariot, the permanent action of which acquires all its force when all pulling ceases. To explain this mechanism more fully, a single cord of gut, starting from the top of this piece and communicating with the chariot by means of two small pulleys, goes up along the amputated limb, passes behind the shoulder, and reaches obliquely the circular band of the trowsers at the braces of the opposite hip.

"When the arm is abducted, this cord, being stretched, acts on the chariot, which, rotating on its axis for a quarter of a circle, carries with it all the lower part of the apparatus, rotating it outwards; that is to say, supinating it. When, on the contrary, abduction is replaced by adduction, the spiral spring we have mentioned gets in action, and brings back the arm by a reverse movement into its normal position; that is pronation.

"The second piece, which performs this movement of rotation over a quarter of a circle, carries in the centre of the upper plate which terminates in a straight rod, which descends through its interior in the direction of its axis. This rod, which for a sufficient length is surrounded by an endless screw, supports, on a level with that screw, a horizontal box, which it raises during supination and lowers during pronation. The box itself carries at its extremities two parallel branches of iron, which terminate a little above the wrist-joint in two transverse metallic button-holes. These button-holes enter a segment corresponding to each of them, cut out of the iron plate which terminates this second piece; they are connected with the pulling of the

fingers. As the action of the endless screw on the box is manifested during rotation, the two branches which terminate it, rising during supination, act on the extensor tendons of the fingers and bring them into action.

"The third improvement is much more important, and consists in this: The hand which is at the end of the artificial arm being exposed, when used, to all kinds of frictions, gets easily dirty; and then it is necessary, according to circumstances, in order that the imitation be perfect, that it should be naked or gloved.

"After a good many trials, M. Bechard discovered a method of unhooking the wrist, by means of a pressure made with the other hand on a button hidden under the coat-sleeve. It will be easily conceived that much patience was required in order to succeed in combining a system admitting of the arm being completely taken to pieces, of changing the hand, and of instantaneously resembling the actions of the extensor and flexor tendons. With this view, the union of the wrist with the second piece of the arm, the mechanism of which has been described, is effected a little above the place occupied by the radio-carpal joint below, by means of a double-toothed pinion entering a mortice hollowed out of the lower surface of the second brachial piece. On each side of this pinion are two prominent buttons, with conical heads above a smaller neck, which correspond to the pulleys of the fingers, divided into two bundles. Both parts are joined together by making the pinion obliquely enter the mortice; the wrist is then made to rotate over a quarter of a circle, in the same way as a bayonet is fixed; and when the rotation is completed, the two metallic buttons come and hook into the two horizontal button-holes, which terminate the two branches of the mobile screw-box indicated above.

"Lastly, the fingers, carefully carved out of wood, show no mechanism externally; all is in the interior. M. Bechard does away with the cord of gut as the acting force, and with spiral springs as the resisting force. A simple flexible steel plate, placed inside, and half flexed, is arranged in such a manner that by pulling on the upper part it produces extension, and the reverse movement, when it ceases to act. The thumb alone is moved (by means of two reflecting pulleys connecting it with the common traction) in such a manner that when the fingers are extended it performs the same movement, and is, besides, abducted, in order to return to the flexed position, and is abducted when at rest. Furthermore, care has been taken, not only to put in its anatomical place the metacarpo-phalangeal articulation, but also to imitate the longitudinal grooves which separate them; this has never been done before, and detracted from the shape of the hand, rendering it unnatural and ungraceful."

"The preceding description applies to an apparatus intended to replace the forearm, amputated below the elbow."

If it is required to replace a limb amputated through the lower part of the humerus, or through the elbow-joints, an armlet is added which embraces the upper part of the opposite arm. This arm-piece serves to give attachment to a traction string, which passes transversely from one shoulder to the other, and, after coming down along the appara-

tus, ends at the upper and inner part of the forearm. This string is destined to produce flexion of the elbow. It is moderately tense in the normal position of a man who is standing, and acts when the sound arm is abducted; on the two points of attachment becoming more distant, the elbow is flexed.

These arms now described are models of mechanical ingenuity and elegance of finish, and have been the groundwork upon which European mechanicians have labored to obtain other less complicated and less expensive limbs, so as to bring them within the reach of all classes of persons who have had the misfortune to lose an arm.

The mechanical and artistic ingenuity of America has not lagged behind that of our transatlantic brethren. Artificial arms are now manufactured here which combine both exquisite workmanship, and all the really useful functions which such a mechanism can perform, at a comparatively moderate expense.

The artificial arm of Mr. Gildea, of Philadelphia, for amputation below the elbow, is an excellent contrivance; and for durability, neatness of finish, and efficiency cannot, I think, be surpassed by any yet invented; its mechanism is simple, and not liable to get out of order; it is modelled in exact imitation of the natural limb; made of willow, and elegantly enamelled. At the metacarpo-phalangeal articulations the fingers are solidly connected together by a transverse bolt, which allows antero-posterior motion only; the fingers are carved from a solid piece of wood, and are in a position of semi-flexion, the index opposing the thumb, and the little finger forming a sort of a hook; the thumb is movable both at the metacarpo-phalangeal and phalangeal joints.

The mechanism of motion consists of a metallic rod, which is connected at its lower extremity to the base of the middle finger, and at its upper to the end of a short lever, which has a fulcrum at the centre of the hand, and projects towards its ulnar border, where a spiral spring connects it with the base of the little finger. Parallel with this lever, and above it, is a second lever, fastened by a fulcrum, at one end to the ulnar border of the hand; a little to the outer side of this point there is a tenon, between which and the inner extremity of the second lever a piece of wire extends, coupling the two levers together; a short distance from the tenon, the upper end of the extensor cord of the thumb, which is of catgut, is attached. A long steel strip passes from the outer extremity of the upper lever, externally, through a perforation upon the radial border of the forearm, and is extended to the upper arm-band by a strap and buckle; the thumb is kept in contact with the index finger by a steel spring formed of several short pieces of watch-spring superposed. The arm is held on the stump by two lateral metallic straps, extending along each side of the arm, and connected above by two padded straps.

When the arm is in use, by giving proper tension to the traction cord the person has only to extend the stump to expand the fingers in grasping objects; the traction-cord acts upon the upper lever, which draws directly upon the extending cord of the thumb, and at the same time forces the radial end of the lower lever with the metal-

lic rod above-mentioned downwards, and as all the fingers are solidly connected with the middle finger, to which the rod is attached, they must be extended. If the stump of the forearm is now flexed, the traction cord ceases to act upon the levers, the thumb and index finger will be approximated by the springs connected with them, and seize the object, whatever it may be, between them.

In this manner a person will be enabled to pick up a pockethandkerchief, or hat, a paper, or other such objects; a pen may also be held in the hand, and with a little practice the person may write very well with it. A basket or satchel, or anything having a similarly arranged handle, may be carried upon the hook formed by the little finger.

Mr. Kolbe, of this city, is also the inventor of a meritorious artificial arm, the mechanism of motion of the fingers consisting of metallic levers acted upon by a single cord of traction; the fingers have the same number of joints as are found in the natural hand. It should be observed, however, in regard to this point—the introduction of numerous joints in the fingers—that it adds little, if any, to the utility of the hand, while, at the same time, it possesses the very decided drawback of requiring a larger number of levers, which add much to the expense and complexity of the mechanism. To overcome the increased amount of friction of the levers, greater power must also be applied upon the traction cords, which in limbs fitted to short arm stumps very much impairs their utility and range of motion.

We have now considered the more complex and expensive artificial arms requiring the greatest amount of mechanical and artistical ability in their fabrication, and which must of necessity be almost, if not entirely, within the reach of the wealthier classes alone. It remains for us to consider briefly those prosthetic contrivances which are simple in construction, and within the means of all persons.

Fig. 150.

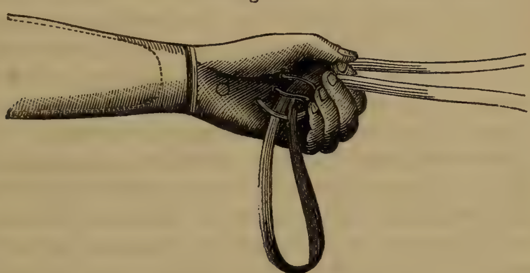
The common artificial arm.

In case of disarticulation at the shoulder-joint, an artificial limb can be constructed and affixed to a shoulder cap or a corset; being modelled in exact imitation of the remaining natural limb, it will restore symmetry to a person's appearance, but little natural motion can be obtained. The limb should not be straight, but possess that graceful curve, Fig. 150, which the natural arm assumes, hanging in its own assumed position by his side, when a person stands erect. For the poorer classes who depend upon mechanical pursuits for a livelihood, an arm without a hand, and terminating at the wrist with a metallic screw plate to which many useful implements may be affixed, will be the most useful. For example, a porter or messenger might find great assistance in a hook for carrying bundles, a basket, or any such articles. Should the amputation have been performed between the shoulder and elbow, a stump will be left which will per-

mit the artificial member to be attached much more easily by shoulder and thoracic bands, and at the same time be much more comfortable to the wearer, who will then be able to dispense with that part of the mechanism required upon the chest, and to which an arm adapted to a disarticulation at the shoulder must be affixed.

Where the amputation is made through the forearm and a freely mobile stump obtained, greater latitude of motion can be impressed upon the artificial member, and the varied occupations in which a person may engage, in consequence, will enable the physician to direct many useful instruments to be affixed to the screw-plate. Such, for example, as a knife or fork, a three-pronged hook for driving, as seen in Fig. 151, or indeed any implement that can be used under these circumstances, and which may be demanded by special trades or callings; even a pen may be used when held by a tube supported upon a stem projecting from the plate, or a pair of forceps. These mechanical contrivances may also be fastened to the palm of the hand, should it be desired to have one in connection with the arm.

Fig. 151.



Arm with driving hook attached.

The sheath must be neatly moulded to the forearm, and may be held in place, if there is sufficient length of leverage, by two lateral bands connecting its upper border with a band surrounding the arm; or if the amputation is nearer the elbow, two jointed lateral stems, connected above with a padded metallic band embracing the arm, will afford more security.

A still more natural appearance and a greater range of useful movements may be obtained by giving to the hand movements somewhat approximating those possessed by the natural wrist and fingers. A glance at the anatomical arrangement of the natural constituents of the wrist-joint will render it evident that the imitation must necessarily be rude and imperfect; yet this can be accomplished to such a degree as to render the artificial movements of considerable assistance. Strictly the wrist possesses but four movements: adduction, abduction, flexion, and extension; and the apparent circumduction possessed by it is accomplished from the facility with which the hand passes from a position of flexion or extension to those of abduction and adduction; there is no rotative motion in this joint. The normal motion possessed by the thumb-joint is flexion and extension with a very slight lateral movement; the thumb derives its extended and varied range of motion

principally from the first carpo-metacarpal articulation, which is really in some degree susceptible of all the motion of an enarthrodial joint.

The mechanical provision in artificial arms permitting rotative motion in the wrist is extremely simple, consisting of a keyhole plug fastened to the wrist-plate and fitting a corresponding keyhole upon the arm-plate; the range of motion of the hand upon the forearm being regulated by a spring in the lower part of the latter catching in a series of indentations upon the wrist-plate. Thus any desired rotative position may be impressed upon the hand at the will of the person. Extension and flexion of the hand may be accomplished with a cup-like depression in the wrist-plate, with which a spherical knob upon the arm-plate articulates, and is secured in accurate contact with it by a little pin connecting its apex with the bottom of the concavity.

No construction yet invented is even a fair imitation of the natural movements of the thumb, which are numerous, varied, and important, and in their perfection are confined to man alone. Other animals, it is true, enjoy some share in them, yet they cannot approximate the tips of the fingers and thumb with that accuracy and firmness essential to the full performance of many digital operations executed by man. It is provided with larger muscles and a greater number than any of the other fingers. The muscles act upon its carpo-metacarpal and two digital joints in divers manners and directions, and thus it can be readily understood how difficult it is, with springs and cords, to produce even a partial similitude to the natural actions. Indeed, little more than a spring can be placed in the centre of the thumb to retain it continuously in contact with the ends of the fingers: so that any object placed in between them will be grasped and held in pretty much the same manner as it would by a common spring clothes-pin.

Though these mechanical arrangements in the wrist and thumb-joints are exceedingly rude and imperfect when compared with the natural organ for the movements of these parts, they yet contribute somewhat both to the natural appearance of an artificial limb and its utility.

The efforts of surgeons latterly in amputating through the various joints of the hand, preserving just as much of that part as the nature of the injury will permit, has resulted in some glorious results for conservative surgery. Even a single finger will do good service, or a part of a finger, when it is practicable to preserve this much, will contribute to a patient's welfare. Many digital operations may be satisfactorily performed by the thumb and index or any one of the other fingers, so that the conservation of the thumb and a digital opponent is of so great importance to a patient that it should always engage the surgeon's earnest attention while performing these operations about the joints of the hand.

Little more can be done by prosthesis in such cases than to restore the symmetry of the part, which may be satisfactorily accomplished by moulding a sheath of leather or other suitable material to the stump of hand to which the missing member may be readily affixed. The deformity arising from the loss of a single finger can be made to disappear by having a glove of an appropriate size to fit the wearer,

and to which a false finger corresponding to the one lost may be attached.

Art still further endeavors to bring nearer to perfection these artificial substitutes by conferring upon them some degree of that softness and elastic feeling of the natural member. This has been to some extent accomplished by means of a coating of India-rubber, which, however, does not possess that smoothness and warmth to complete the deception of the sense of touch.

From the foregoing consideration it will be seen that it is not an indifferent matter as to the place at which the amputation has been effected, as regards the ease with which an artificial limb may be attached, or the amount of utility such a mechanism possesses. It has been seen that, when disarticulation has been performed at the shoulder or the amputation performed near to it, the arm must of necessity be attached to some contrivance upon the chest, and thus complicate the mechanism and inconvenience the patient; at the same time there is no stump to exercise a leverage upon the arm and thus extend its range of motion.

Of amputation between the arm and elbow, the point most convenient for the adaptation of a prosthetic substitute is that at the junction of the middle with the lower third, though with care an arm may be made for a stump of any length. Perhaps the mechanical difficulties culminate in an amputation through the elbow-joint, which will give a large and broad stump liable to be pressed upon injuriously by the lower part of the arm sheath, and also to interfere with the mechanism of the elbow.

Two-thirds of the length of the forearm will give a gently tapering stump to which an arm may be fitted with ease, and possess as great a range of movements by the action of the stump as can be attained by any other length. More stump than this will embarrass the motions of the wrist-joint, and occasionally be the source of annoyance to the patient by pressure of the sheath upon its extremity.

SECTION IV.

APPARATUS FOR REMEDYING DEFICIENCIES OF THE LOWER EXTREMITIES.

Deficiency of the Leg.—The necessity for an artificial substitute after the loss of a lower extremity is far greater than for that of an arm; the loss is more seriously felt when a person is dependent upon his avocation for maintenance, and is compelled to make active exertion in the execution of the duties it imposes upon him. Should the free use of both hands be necessary, he will also find the amount of assistance they afford materially diminished if compelled to hobble about upon a crutch, which imperiously calls for the service of one of his hands. So we might, in such a case, really say that the loss of a leg also implies that of an arm, which, hitherto peculiarly devoted to the performance of varied and important actions executed by this organ, is now turned away into a new channel, and assumes a participation in the office of progression. The ordinary crutch was, of course, the first kind of mechanical assistance that would have natu-

rally suggested itself to do away with the accompanying inconveniences, and incapacity of moving about, yet at a very early period artificial legs were used, and this suggests the superior importance in which the construction of legs over arms was held by the ancients, as they have transmitted absolutely nothing concerning the preparation of the latter, as has already been stated in the previous section, while several authors describe artificial legs.

If we first consider the mechanical circumstances under which a natural leg is placed, we shall be better able to appreciate the advantages and disadvantages of the various kinds of prosthetic apparatus destined for the lower extremity, and the conditions which they must fulfil in order to meet the requirements and necessities of a person compelled to employ them in the act of progression. The human body in health, standing erect at ease, has the heels approximated and the toes turned outwards, so that the axis of the foot cuts the line of direction of progression at an oblique angle, and has its various parts distributed in equilibrium about a central axis or line A D, of gravity, which, starting from the vertex of the head, falls between the occipital condyles, passes thence downwards to the tip of the coccyx, and terminates at a point upon the plane upon which the person stands, midway between the two heels. This line of gravity remains unchanged as long as the equilibrium is undisturbed; but the moment the person changes his position, as in walking, the equilibrium is altered, and necessarily the line of gravity, which is shifted alternately, as the weight of the body is borne first upon one leg and then upon the other, to positions represented by the dotted lines A E, A C (Fig. 152). In this manner, while the equilibrium of the body is established around an axis passing from the vertex through the ischium and coinciding with the axis of one of the lower extremities to the sole of the foot, the opposite extremity swings forward after the pelvis is thrown forward by the extension of the limb to that position necessary in taking a step, by the force of gravity alone; so that really little or no muscular force is expended except that consumed in flexing the leg to an extent requisite for raising the foot from the ground.

Fig. 152.

The experiments of the Webers conclusively prove that the legs of a dead body, held in an upright position and moved forwards, may be made to execute the movements of those of a living person in progression, if a substitutive force for that exerted by the muscles in lifting the feet from the ground be employed.

Of the four joints of the lower extremity, the hip, knee, ankle, and first metatarsal phalangeal articulation, which in an especial manner contribute to the ease and efficiency of walking, the ankle-joint, including the connections between the tarsal bones, deserves especial attention, as it is the difficulty of imitating

their movements which has hitherto been in the way of the surgeon in devising an artificial leg possessing life-like actions. The tibio-astragalal articulation permits flexion and extension with a slight degree of rotation, while the articulations between the tarsal bones themselves confer most of the power of abduction and adduction and rotation enjoyed by the foot. With this extended range of motion at this point, the muscles of the lower extremity bring with ease the body in equilibrium about the line of gravity of the limb, and therefore this joint must contribute largely to rapid and graceful walking. Were this otherwise, as indeed sometimes happens in diseases of the bones of the foot and consequent anchylosis of the joints, and the movements of the ankle restricted to simple flexion and extension, for instance, the muscles could not readily balance the body when supported alternately upon one leg and the other in walking, and the gait would then be awkward, slow, and shuffling. The weight of the body, when a person stands upon one foot, is sustained in the direction of a line running through the femur, acetabulum, tibia, and the arch of the foot, by these osseous pillars placed in the interior of the lower extremity. The centres of the knee and ankle-joints are placed somewhat behind this line, so that when the limb is straight the weight of the body adds to their strength, and relieves the muscles greatly in sustaining the body erect.

With these mechanical conditions under which a natural limb is placed in supporting the weight of the body, either at rest or in the act of walking, impressed upon the mind, we are prepared to understand how far the various artificial substitutes do and can fulfil their purposes when the loss of a limb compels a person to seek their assistance. Those persons who have paid much attention to this subject, and devised such apparatuses, have been more or less successful in proportion to their knowledge and appreciation of the anatomical structure and physiological actions of the natural limb.

Commencing with the foot, we shall see that the prosthetic apparatus for it, although contributing somewhat to progression, are more especially employed to correct deformity. The class of operations requiring them are amputations and resections: among the former are ranged Syme's, Chopart's, Hays' and Perigoff's operations; and among the latter the removal of the astragalus or os calcis separately, or both together, as in the process of Mr. T. Wakely, Jr. When there is a sound and well-formed stump obtained by any of these processes, which will sustain the weight of the body without pain, the walking of a person so maimed may be materially assisted by the shoe represented in Fig. 153, which has a sole of sufficient thickness to make up any difference in the length of the two limbs, and supports the parts by lacing high up upon the ankle.

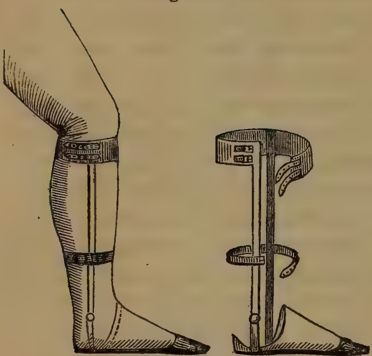
Fig. 153.

Shoe after amputation at ankle.

The addition of an artificial foot is a question of considerably more mechanical difficulty, from

the fact that there exists great difficulty in fastening the shoe to the stump in such a manner that it will not press upon its anterior surface, which must occur if the artificial foot is placed against it, every time the leg bends forwards in locomotion. To prevent this upward action of the artificial foot, it is simply necessary to provide a metallic sole, upon the upper surface of which there is a padded socket to receive the stump and part of a foot, in exact imitation of the lost portion of the natural organ, and having a toe-joint. Its posterior extremity is deeply grooved to fit accurately the anterior surface of the stump, to which it is fastened by straps. To the metallic plate there are fastened two steel rods, running up the leg to the knee, one upon each side, provided with bands, &c. to secure the apparatus in place; corresponding to the ankle-joint, there is placed a stop-joint, which prevents the anterior part of the foot being flexed at more than a right angle with the leg. When the artificial substitute is securely connected with the leg, and the patient attempts to walk, as the heel is lifted the stop-joint sustains the foot at right angles to the leg until the pressure comes upon the toe-joint, which yields immediately, and thus imparts a natural motion to the step without lifting the front of the foot sufficiently to throw its upper and back part against the stump.

Fig. 154.



Apparatus for amputation through the foot.

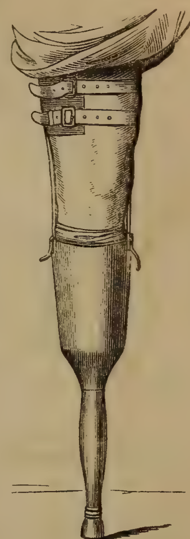
If the toes or anterior part of the metatarsus are simply removed, an ordinary shoe, with its anterior portion properly padded, will serve the purpose of concealing the deformity. The same plan may answer also after Hey's operation; should it not, however, in consequence of the tilting of the artificial part against the end of the stump, the previous plan must be adopted.

After the resections above mentioned, the only prosthetic apparatus required will be a common shoe with a sufficiently high heel to make up the difference of length between the injured and sound limbs.

In the foregoing cases the weight of the body is borne upon the stump; but when the amputation is performed between the knee and ankle, this cannot be done, however skilfully the operation may have been executed, or however successful it may have been in securing a well-covered and fleshy stump. In any case, the weight of the body would soon cause the soft parts to be absorbed, and the end of the bone to protrude. It scarcely matters much how great a mass of muscular substance may be placed over the bone, for in the course of a few months the tissue will become atrophied and converted into a dense cellulo-fibrous mass, and the end of the bone rounded off and conical. As this is the natural method observed in the subsequent modelling of the extremity of an amputated limb, it would seem that too much stress has been placed upon the importance and supe-

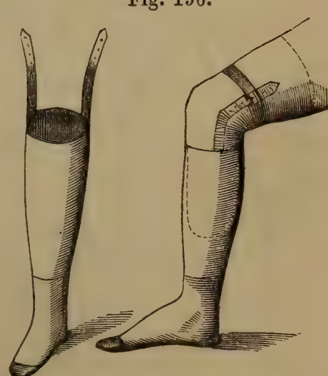
riority of certain processes over others in securing the best stump for an artificial leg; when the truth really is that no greater thickness of tissue will be found over the bone after the lapse of a twelvemonth, in operations with voluminous muscular flaps, than after a circular operation with flaps of skin and cellular tissue. In either case, if the stump is well rounded and sound, it will suffer with impunity the amount of strain brought to bear upon it in employing an artificial leg. As stated above, the natural limb has but one point of bearing, that is, in its axis or line of gravity, but this cannot be imitated in adapting a prosthetic apparatus, from the stump being intolerant of pressure; so that the surgeon is compelled to make a point of bearing of the entire outer surface of the stump, by inclosing it in an accurately fitting sheath of stout leather or willow. This diffusion of pressure over as great an extent of surface as possible should always be kept in view in making artificial socket limbs of any description, for it is manifest that the local effects of pressure or force of any kind must diminish in the ratio of its diffusion over the surface upon which it acts. The common socket-leg (Fig. 155) is constructed in this manner, with an accurately-fitting wooden sheath, into the bottom of which a pin of the same material is inserted, to make up the distance between the stump and the ground. The leg is prevented from falling off by the lateral straps connected with a leathern thigh-band. A still more seemly artificial leg (Fig. 156) is manufactured, which, instead of the pin attached to a socket, has a foot with movable ankle and toe joints, and is fastened in the same manner as the socket-leg. This point will, however, depend much upon the length and condition of the stump, which, if but three or four inches long, will require two lateral metallic stems joined at the knee, and fastened above to a metallic thigh-band, that the stump may not be drawn from the socket while the person executes the act of locomotion. Equally as great an evil is a too lengthy stump, the end of which is constantly liable to rub against the inner surface of the sheath, and cause the wearer of the leg constant pain or uneasiness while moving about. This rubbing often occurs upon the anterior surface of the tibia, and may demand that that part of the wall of the socket corresponding to it be removed, so that the end of the stump may

Fig. 155.



The common socket-leg.

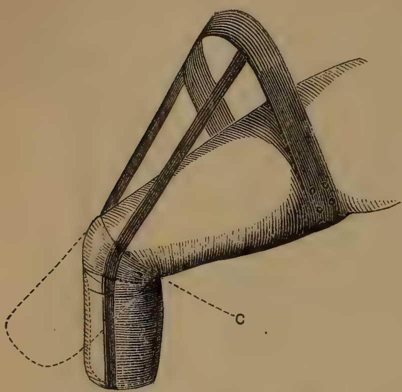
Fig. 156.



Artificial leg for amputation below the knee.

have unrestrained play. Again, where the stump is badly healed and tender, and cannot bear the pressure of the socket, the artificial leg must be still further modified, so as to receive the weight of the body upon a leather cap fitting inside of the socket and closely embracing the stump as high up as the tubercle of the tibia.

Fig. 157.

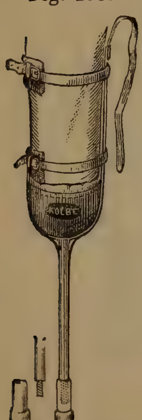


Apparatus for extending a contracted stump.

It sometimes happens, also, from the shortness of a stump, or other cause, that it remains after the lapse of some time in a permanently flexed position, requiring, before any of the above forms of prosthetic apparatus can be had recourse to, that it be extended and restored to some degree of mobility. To accomplish this, the simple apparatus seen in the figure (Fig. 157) may be employed; it consists of two lateral-jointed metallic rods, connected below by a metallic gutter fitted to the posterior surface or calf of the leg, and extending above the knee. A strong cloth band, crossing the patella and attached to the two rods upon either side, serves the purpose of a fulcrum. The extending force is applied to the upper extremities of the bars by means of an India-rubber band passing between them and the thigh.

Another form of artificial leg (Fig. 158) for a stump below the knee, is the common wooden pin or "box leg." It consists of a wooden frame widely grooved below to accommodate the knee, and of two lateral side pieces; the external, slightly curved backwards, reaches from the knee to the crest of the ilium, and the internal, half way up the thigh; from the bottom of the socket a pin projects, and makes up the interval between the knee and the ground.

Fig. 158.



The "wooden pin."

The apparatus is fastened to the body by a strap passing around the waist, and the outer and upper end of the side piece; to give the leg stability and insure firmness in stepping, the pin must be mortised squarely at the knee, and with as broad a base as possible. To prevent the projection of the superior extremity of the leg backwards when the person sits down, a joint may be placed upon it at a point corresponding to the articulation of the hip.

M. de Beaufoy has invented a foot for the wooden pin worn by the pensioners at the Invalides at Paris. The advantage of this improvement, says Guthrie, is "that whereas a common wooden pin has only one point of support, and consequently the body is obliged to raise itself so as to describe an arc of which the end of the wooden pin is the

centre, the curved foot acts like a series of levers, each successive point of it being a fulcrum."

The weight of the body with this leg is borne upon the knee, and is transmitted to the ground in the normal line of the centre of gravity of the limb.

For amputations of the thigh we will not find as great a variety of artificial limbs, from the circumstance that they present us with a stump of a pretty uniform character as to length and shape; yet it is here that we find the greatest efforts of mechanical ingenuity displayed, and the greatest number of methods by which the mechanical requirements of an artificial leg are fulfilled. The mechanical conditions under which a natural leg is placed while the function of locomotion is being executed have already been briefly alluded to, and it was stated, then, that the weight of the body in changing its position in walking was thrown alternately upon one and the other leg, and supported in a line of gravity running through the acetabulum, femur, and bones of the leg; that there was but one point of bearing, and that was central; that the muscles were chiefly concerned in raising the foot from the ground, and that the gravitation of the limb carried it forwards to its destined position.

Prepared with these facts, we can now inquire how these conditions may be realized in a prosthetic apparatus:—

1st. As to the points of support or bearing: We cannot mechanically restore that part of the line of gravity represented in the natural limb by the femur, and destroyed with the removal of the leg; as the only way to do so would be to make the end of the divided bone a point of pressure by establishing again the same length of bony column which supports the body naturally (which, as we have already shown, is impossible). The only way, then, is to inclose the stump in a sheath, technically called "a bucket," to diffuse the pressure over its surface to as great an extent as possible, and thus to transmit the weight of the body to the ground, not through a central axis of support, but by a circumferential support, that is, by the walls of the bucket; which is just the reverse of the natural condition of things, but an imposed necessity. Were there a projecting point about this central axis capable of bearing pressure, and against which the upper edge of the bucket might rest in supporting the body, the result would be much more satisfactory than any we now obtain by pressure upon the surface of the thigh stump. It has been suggested that the ischium, which lies posterior to this line, might serve as a circumferential point of bearing; and with this view the upper edge of the bucket of some artificial legs ascends to it, and the plan answers exceedingly well.

2d. The provisions for the imitation of the natural action of the joints have until lately been very unsatisfactory; and it was not until the invention of Dr. Bly's leg that little was left to be desired in this direction. An examination of the structure of the knee and ankle-joints teaches us that their centres lie a little in the rear of the line of gravity of the limb, estimated to be a half an inch for the knee and three-quarters of an inch for the ankle, so that, when the limb is straight, the greater the weight transmitted to them the more firm they are. So in an artificial

limb, the articular centres or bolts should be placed in the rear of this line the same distance, that when the person rests the weight of his body upon it, the joints will afford a firm and secure support, and be reinforced just in proportion to that weight.

3d. The varied actions of the muscles of a natural limb in the execution of all their functions cannot be fully imitated in any artificial mechanism, but those chiefly active in locomotion may be to a reasonable practical extent. As to the knee-joint, as the limb swings forward by gravity and extends the leg, really no mechanical contrivance for this purpose is at all required, but with the ankle it is quite otherwise: here some provision must be made for the flexion and extension of the foot, else in walking the toe would either be constantly catching against every uneven spot or projecting point upon the ground, or approaching the front of the leg, the person would walk upon the heel alone, if the weight of the body did not bring the toe down, as it would in the latter case, with a heavy stroke.

The foot must be then secured at right angles to the leg, in such a manner that, after being either flexed or extended, it will spontaneously and promptly return to its original position when the force is removed. This can be accomplished in several manners, with elastic cords, spiral springs, or gut cords fastened to an elastic metal slip placed in the sole of the foot. India-rubber is an exceedingly valuable material in the construction of artificial limbs, and is employed to imitate the action of muscular fibres, from its capacity of contracting promptly after being stretched; but after being used some time, it loses this indispensable property to a greater or less extent, and is then apt to break. Dr. Bly happily overcame this objection by availing himself of the expansive power of railroad car-spring rubber, after compression, in which manner it cannot be injured, however much it may be used. Its application will be seen hereafter.

Spiral springs are arranged in the ankle in the manner seen in the figure (159), one in front of the instep and another in the position of

Fig. 159.

Diagram showing the mode of arranging spiral springs in the ankle and their action.

the tendo-Achillis. Although possessing the valuable properties of exercising expansive force when compressed, and contractile force when extended, they are inferior to the rubber springs used in the Bly leg,

which give a more uniform and natural movement to the limb; they do not become weak by use, nor yet do they rust or produce any roughness or creaking noise.

It now remains for us to consider the prosthetic apparatus at present in use, and see how the above detailed mechanical principles are carried out in their construction. The simplest of the artificial legs is that composed of an accurately fitted "bucket," the upper margin of which should abut against the ischium, and of a wooden pin to make up the distance to the ground: it is fastened to the person of the wearer by a strap passing around the waist. A more convenient limb than the above may be obtained by providing it with a hinge corresponding with the knee, and controlled by a spring check-slide, placed upon the inner side of the bucket, so as to catch in a ratchet fastened to the same side of the leg-piece. This arrangement places the command of the movements of the knee-joint under the control of the person wearing the artificial limb, and enables him, when seated, to flex it, so that the pin will not inconvenience or trip persons moving around him, as it would do if it were straight and stuck out in front.

The two preceding limbs are simple in their construction, and within the reach of the poorer classes, who are debarred from the use of the legs now to be described in consequence of their high price. The best of these, and the one we shall describe first, is that of Dr. Bly, of Rochester, N. Y., who has succeeded in producing a mechanism the movement of which imitates very closely those of the natural limb. It is adapted to an amputation above or below the knee, and it is particularly where this joint is preserved and enjoys its normal motion that Bly's limb possesses a point of superior merit in external form. The artificial limbs for stumps below the knee, made formerly, were attached to the wearer's person by two straight lateral steel straps, jointed at this articulation; the angles formed by these metallic joints must project when the limb is bent at right angles, and raise the person's clothes in such a manner as to give the part an unnatural, bulky, and square appearance, at variance with the normal symmetry of the leg. Dr. Bly has overcome this objectionable feature perfectly by curving both the leg and thigh-straps in such a manner as to throw their point of junction further to the rear, on a level with the centre of the knee-joint, so that the clothes remain smooth when the knee is bent in assuming a sitting posture.

This natural symmetry of the knee-joint is in accord with, and harmonizes with the perfection of form conferred upon the other portions of the limb, which, to bring it still closer in appearance to nature, is covered with a flesh-colored enamel, permitting a free use of water for cleansing and refreshing its surface.

Besides these details of external form, the far more important questions of the mechanical construction and motive powers of the joints have developed the ingenuity of Dr. Bly, and prove how indispensable a competent knowledge of Anatomy and Physiology is, to enable a person to design and prepare any apparatus in the treatment of the diseases and deficiencies of the human body. As we have seen, the leg is carried forward by gravity, when the foot is raised from the

ground, and the hip corresponding to it swings forwards in an arc with its centre at the acetabulum of the opposite side, so that in reality there is no need of any motive power being placed in the knee-joint; yet in the construction of the artificial limb under consideration, some provision of this kind is made. A spring of railroad-car spring India-rubber is introduced, which, by its expansion after being compressed by flexing the leg, urges the latter forwards in taking a step; and when the foot comes to the ground, in order to prevent shock, or any irregular action of the knee-joint, two cords are arranged to check its movements in imitation of the crucial ligaments in the natural articulation. The bucket, or thigh-sheath, articulates with the leg with the usual steel bolt; indeed the bolts are the only iron used at all in any part of the construction of the limb, which confers upon it the important quality of lightness, and a superiority in this respect over those mechanisms in which that metal enters. The friction of these metallic joints implies more or less wearing of iron, and must, therefore, necessarily become loose, and unless repaired by bushing, rattle at every step; they also demand the free use of the oil-can to destroy their unpleasant and annoying clatter. In the ankle-joint the case is different; there nature provides a number of muscles and a joint of peculiar construction for sustaining the leg in that line with the foot required by the gravity of the body, and for accomplishing the action of progression. It is in this respect and the form of the ankle-joint that the Bly leg possesses undeniable superiority over all others, if close imitation of the arrangements and functions of the natural limb will entitle it to a superiority. The ankle-joint naturally possesses four motions, flexion, extension, abduction, and adduction, which, readily passing from one to another, confer a compound motion equivalent to circumduction, enjoyed alone by the enarthrodial or ball-and-socket joints. The indispensableness, too, of this sort of compound motion in the ankle, for quick and easy progression, is seen when we observe a person walking gracefully and rapidly: the toes naturally turn outwards, and the foot performs a sort of oblique antero-posterior movement, which could not be accomplished with a ginglymoid joint, a form of articulation adopted in most artificial limbs, except that of Dr. Bly. He employs a ball-and-socket joint for the ankle, the ball being of ivory and the socket of vulcanite, so that all the motions observed in the natural foot may be effected by the foot of his artificial limb. Further, the joint does not wear, nor require oiling, or bushing to keep it tight, but may be used for years unceasingly, without requiring the outlay of any more money than the original cost of the limb. The foot will remain flat upon the ground, should the leg be thrown out to brace the body for any unusual exertion or effort; and in walking upon the side of a hill, or any other inclined or uneven surface, the sole of the foot will assume a natural position, parallel with the plane upon which it rests.

In the ginglymoid ankle-joint of other artificial limbs, this oblique action of the foot in locomotion can only be imitated by rolling it laterally; and when the person wearing a leg constructed with such a joint walks upon an inclined or uneven surface, the side of the foot

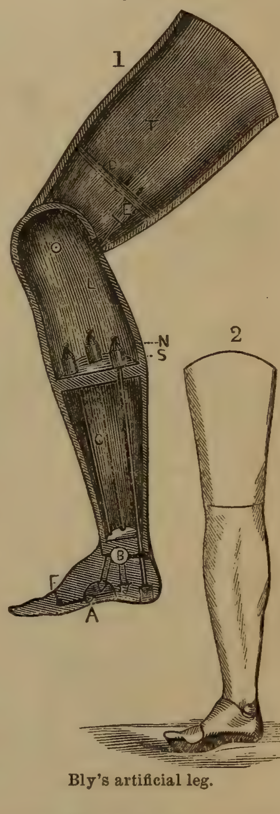
alone remains in contact with it, while the upper edge of the bucket must be in consequence thrown forcibly against the thigh, much to his discomfort, and the impairment of firmness of step.

The foot in Bly's leg is under the control of five catgut cords, connected with an equal number of India-rubber springs; these being placed beneath movable nuts, connected with the cords, traction of the latter compresses the India-rubber, and its expansion exerts the moving power of the foot. By adjusting the nuts, any desirable tension may be given to the cords to suit the person's gait.

The toe-joint is also furnished with an India-rubber spring and catgut cord.

The readiest way of understanding the foregoing description of this artificial limb is to examine attentively the annexed illustration. Fig. 160 shows a section of a limb for amputation above the knee. T is the bucket with the piece D spanning the diameter of its lower part, and to which a cord and spring are affixed, ascending from the posterior part of the leg and serving the purpose of urging the leg forwards after it has been bent in taking a step. L is the leg-piece articulating at the knee with the bucket T, and having a diaphragm across its middle part through which the catgut cord C passes to be secured by the movable nuts N, between which and the diaphragm the springs S of railroad-car spring India-rubber are placed. There are but three of the five gut cords shown in the figure. B is the polished ivory ball working in a concavity lined with vulcanite. In the posterior half of the foot are seen the lower attachments of the gut cords, imitating the natural tendons. In the forepart of the foot, A F, the toe-spring is shown. Fig. 160, 2, shows the position the foot assumes when it treads upon a projecting object.

Fig. 160.



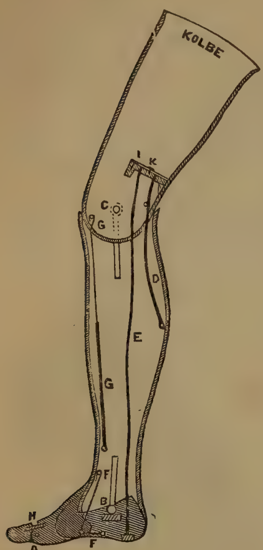
Bly's artificial leg.

Mr. Kolbe, of Philadelphia, has devised a leg in some respects superior to that of Bly. It possesses slight lateral motion of the ankle, enough to relieve the strain upon the thigh-sheath when the person steps upon an irregular or an inclined surface, while at the same time it does not render the walking unstable, as it must do if too great an amount of motion is given to the ankle.

The external finish and strength of the limb give it rank with the best automatic appliance now offered for the patronage of the maimed, and one great recommendation it possesses is, that it may be adapted to every form or length of stump.

Its mechanism is so simple that the wearer of the limb can in general be his own repairer should any portion of it give out or need overhauling, and this is no small advantage to persons residing at a distance from the manufacturer.

Fig. 161.

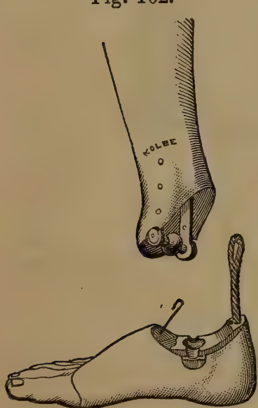


Kolbe's artificial leg.

The annexed cut (Fig. 161) shows a vertical section of a limb designed for an amputation of the thigh. As is usual, the framework is of willow wood, which is selected for its tenacity, strength, fine grain, and lightness. The thigh-piece or *bucket* is commonly lined with washed leather, fitting the thigh accurately and extending up to the ischium and perineum, which sustain a part of the weight of the body; the balance being diffused over the outer surface of the thigh. Its walls are opened by oblong slits or fenestræ, which permit the proper amount of ventilation being effected, and, at the same time, allow the secretions of the part to escape.

The thigh-piece is strongly articulated at the knee to the leg-piece by a steel bolt, which permits antero-posterior motion only. From the inner surface of the lower third of the bucket a wooden pin, I K, projects, to which are attached two strong cords made of twisted linen thread. One of these, I E, being inserted into the heel, represents the tendo-Achillis; it supports the weight of the body by preventing the foot being bent at any greater angle than a right angle. The other cord, K D, is inserted into the middle of the posterior surface of the leg, and is accessory to the former, an arrangement by which the limb is rendered so exceedingly strong that the weight of the strongest man cannot impair its stability. The cord marked G G is a spiral spring which is intended to give the leg a slight impulse forwards in taking a step; it is the analogue of the extension quadriceps of the natural limb. It has already been stated that this is useless, and experience proves it, in that most persons after becoming somewhat familiar with the motions of the leg throw this elastic strap aside.

Fig. 162.



Mechanism for lateral motion.

Fig. 162 shows the mechanism of the ankle-joint. It is somewhat peculiar, combining all the strength of a ginglymoid joint with lateral motion. The inferior surface of the leg and the corresponding surface of the foot are provided each with a hemispherical depression which, when conjoined, form a hollow sphere; in the interior of this sphere the globular en-

largement seated at the centre of the steel ankle bolt works, the extremities of the bolt passing through the lateral metal straps in holes a little larger than their diameter; these extremities are sustained by two pieces of India-rubber, which permit that amount of lateral motion desirable in the ankle.

F F, in Fig, 161, indicate the position of a cord attached to a horizontal metallic spring fastened to the sole of the foot and intended to bring the foot again to a rectangular position with the leg after it has been extended: it is the analogue of the tibialis anticus.

H A mark the metatarsal phalangeal joint; it is a simple tenon and mortise joint firmly bolted together, and under the control of a metallic spring which brings the toes straight with the foot after they have been extended by the weight of the body.

Another automatic appliance of American invention is the Palmer leg. It is perhaps the best of the old style of artificial limb, and has hitherto enjoyed the approbation of the profession generally for its lightness, the ingenuity displayed in its construction and finish, and for that essential desideratum, efficiency. Mr. Palmer describes his invention in a pamphlet published by him in the following manner:—

"The articulation of knee, ankle, and toes consists of detached ball and socket joints. The knee and ankle are articulated by means of the steel bolts, combining with plates of steel firmly riveted to the sides of the leg. To these side plates are immovably fastened the steel bolts. The bolts take bearings in solid wood (properly bushed) across the entire diameter of the knee and ankle, being stronger, more reliable and durable than those of the usual construction. All the joints are so constructed that no two pieces of metal move against each other in the entire limb. The contact of all broad surfaces is avoided where motion is required, and thus friction is reduced to the lowest degree possible. These joints often perform for many months without need of oil or any attention—a desideratum fully appreciated by the wearer.

"The tendo-Achillis, or heel tendon, perfectly imitates the natural one. It is attached to the bridge in the thigh, and passing down on the back-side of the knee-bolt, is firmly fastened to the heel. It acts through the knee-bolt on a centre, when the weight is on the leg, imparting security and firmness to the knee and ankle-joints, thus obviating all necessity for knee catches. When the knee bends in taking a step, this tendon vibrates from the knee-bolt to the backside of the thigh. Another cord descends through the leg so as to allow the foot to rise above all obstructions, in flexion, and carries the foot down again, in extension of the leg for the next step, so as to take a firm support on the ball of the foot. Nature-like elasticity is thus attained, and all thumping sounds are avoided.

"Another tendon of great strength and slight elasticity arrests the motion of the knee gently in walking, thus preventing all disagreeable sound and jarring sensation, and giving requisite elasticity to the knee.

"A spring, lever, and tendon, combining with the knee-bolt, give

instant extension to the leg when it has been semi-flexed to take a step, and admit of perfect flexion in sitting.

"A spring and tendons in the foot impart proper and reliable action to the ankle-joint and toes. The sole of the foot is made soft, to insure lightness and elasticity of step.

"The stump receives no weight on the end, and is well covered and protected to avoid friction and excoriation."

The Anglesea leg is generally adopted in England; it is so named after the Marquis of Anglesea, who exhibited a lively interest in the perfection of the limb, and used one himself. Like the Palmer leg, it consists of a wooden frame, imitating in shape the natural leg, and having the ordinary mortise and tenon joints, with iron bolts through their centres at the knee and ankle and moved by a catgut cord, representing the flexor muscles of the leg and extensors of the foot, extending from the heel to the knee; a strip of India-rubber is arranged in the forepart of the instep between the sole of the foot and the middle of the calf of the leg, for the purpose of flexing the foot. The action of the cord is to extend the foot when the leg is straightened, while in the bent position, just previous to making a step, it being relaxed, the elasticity of the instep band raises the toes from the ground, but not in such a manner or to such an extent as to give the heel a chance to touch the ground first when the foot takes its position in advance of the person, as is observed in the natural gait. The toes touch first, and the weight of the body brings the heel down with a shock.

This construction also requires the leg to be made shorter than the natural one, in order to prevent the persons tripping at every step over the slightest inequality of the surface upon which he may be walking.

Not possessing the lateral movements of the ankle, as in the Bly and Kolbe legs, it is open to the objection of pressing painfully upon the thigh, and impairing the stability of stepping whenever one side only of the foot rests upon an oblique or irregular surface.

In France and Germany elegant artificial limbs are manufactured after the models of Ferd. Martin, Mille, Charrière, Bechard, and Mathieu.

CHAPTER II.

APPARATUS FOR REMEDYING LOSS OF FUNCTION OF PARTS OF THE BODY.

THE loss of function of parts now to be considered affects principally the muscles and their tendons and the ligamentous structures connecting the different elements, or opposing articular surfaces entering into the composition of the joints. In their normal condition the muscles and tendons exert themselves uniformly and harmoniously in maintaining due balance in the execution of the respective offices of the

various portions of the human frame with which they are in connection, and retain in their position those organs inclosed by them.

That the tendons participate in the production of certain deformities and other pathological states, as well as the muscles with which they are continuous, would seem to be proven by the observations of M. Jules Guérin, who dissents from the doctrine taught by Bichat and succeeding anatomists, that tendons are the passive instruments for the transmission of motion originated by the muscles, and have no contractility. Their contractility, it is true, cannot be excited like that of muscles by galvanism, resembling in this particular the dartos and some other contractile structures, yet that it does occur in certain pathological states, such as the deviation and deformities in the joints following some of the gouty, rheumatic, and scrofulous inflammations seated about the tendons, would seem to be established by accurate observation of those classes of disease.

M. Guérin asserts also that he has demonstrated that, under a determinate condition, such as constant and excessive tension, a muscle may be converted into a fibrous condition, resembling in every histological particular its tendon, of which it now forms but a mere prolongation. Further, he had observed that muscles evidently in a fibrous state prior to section, the result of which was the restoration of their normal length and tension, frequently, in the course of years, or even of months, regain their fleshy condition. This latter observation has an important bearing upon the mechanical treatment of the loss of function of these organs, inasmuch as it shows that though their fibres may be deeply involved in organic change, atrophy, and conversion to a fibrous state, the persevering use of appropriate measures may, after the lapse of months, restore them to something of their pristine vigor and healthfulness.

Deformities often result when one set of muscles lose the habitual and normal antagonism constantly exerted by an opposite set in consequence of their being paralyzed, or subject to some organic alteration; or a muscle may overcome, by exaggerated action, its antagonist acting normally.

As a general rule, the abnormities of function of parts of the body are more remediable by mechanical appliances when the unequal action of the muscles result from local causes than when it occurs in consequence of some permanent or long-continued morbid alteration of the system at large, as of the nervous centres. Hence, the paralysis of the limbs from centric causes is in general but little alleviated by the use of any apparatus; while in other instances, in which local changes are the sources of altered function, much benefit is almost always derived from proper treatment, and cures are not unfrequently obtained.

Besides these causes—changes in the muscles themselves, and centric or excentric paralysis—of loss and impairment of function of the muscles, a peculiar sort of paralysis is sometimes observed in hysterical persons, which is simply the result of exalted nervous action, and implies no local change in the muscles further than may result from the long-continued inaction during this state, nor permanent change in

the nerve-centres. Such cases are frequently cured as soon as the condition upon which they depend is removed, whilst any lingering impairment of the tone of the muscles, after successful general treatment for the hysteria, may be advantageously met with exercise, localized movements of the affected muscles, and appropriate apparatus.

As most of the diseases falling under the present head are chronic, they require chronic treatment; an overweening confidence in apparatus of any description for a speedy cure will surely be disappointed. The patient must exert himself to obtain full control over the affected muscles by a vigorous exercise of his will, to develop any remaining muscular power while the surgeon endeavors to supplement it with properly arranged mechanical forces to overcome the stronger action of opposing muscles, and at the same time employs frictions of the parts with stimulating applications for the purpose of exciting the capillary circulation and rousing the dormant nutritive activity. The mechanical manipulations should be employed for a short time only at first, and the periods gradually lengthened as the restoration of function progresses, observing regularity, the patient bearing in mind always that no good results can be accomplished by fitful and irregular treatment; one, perhaps, carefully observed for a few days and then dropped for a week, or some indefinite period, to be again resumed at the suggestion of his caprice.

SECTION I.

APPARATUS FOR REMEDYING LOSS OF FUNCTION OF THE MUSCLES OF THE HEAD AND NECK.

Loss of Function of the Cervical Muscles.—It occasionally happens that the extensor muscles of the head, in consequence of paralysis, are unable to maintain it in an erect position, and in consequence the head falls forward towards the chest, the chin reposing upon the upper part of the sternum. The same result may also occur from the active and permanent contraction of the flexors of the head, the erectors opposing little if any resistance to their action in causing the displacement.

The course of treatment to be pursued should have especial reference to the improvement of the general health by tonics and appropriate exercise, aiding the restoration of the power of the muscles affected by systematic localized movements. It is important to discriminate this affection from that in which the forward inclination of the head depends upon disease of the substance of the vertebræ themselves.

To maintain the head erect, if no resistance is offered by the flexor muscles, two curved padded stems, projecting upon either side of the neck from the upper extremity of a long metallic lever running along the spine, may be placed beneath the chin; the head being rendered more steady by a circular strap passing around the forehead. The stems move laterally in opposite directions, and by means of a ratchet screw, controlled by a key at their junction with the vertebral lever, may be elevated or depressed at pleasure; the lever itself takes its

support upon the pelvis by two straps passing around the body; and opposite the axilla two curved supports project from it beneath the shoulders.

A still more convenient apparatus is formed by attaching to the upper end of the vertebral lever two arms padded at their extremities to grasp the sides of the head, and capable of being separated laterally and moved upwards and downwards by ratchet-centres.

Should the muscles involved in the paralysis permit the head to fall sideways upon the shoulder, either of the above instruments, with the addition of a lateral centre of motion to the vertebral lever in the neighborhood of the seventh cervical vertebra, will suffice to sustain the head erect, while the constitutional treatment appropriate to the diseased condition upon which the paralysis depends, is being carried out.

SECTION II.

APPARATUS FOR REMEDYING LOSS OF FUNCTION OF MUSCLES OF THE TRUNK.

Apparatus for Remedying Loss of Function of the Erector Muscles of the Spine.—In the natural condition of the muscles and ligaments connected with the spine, that column is maintained with the greatest facility in the erect position without fatigue or exertion. For this purpose the large and powerful muscles lying in the vertebral grooves, with numerous connections with the bodies and processes of the vertebræ, are admirably adapted. The varied movements of the body involve more or less disturbance in the equilibrium of the spine, which is promptly restored by the energy of the muscles as soon as the disturbing influences are removed.

Certain departures from this normal action of the vertebral muscles and ligaments are sometimes observed, and are designated usually "spinal debility." In its mildest form it consists in a simple debility of these tissues, the muscular fibres losing tone, and partaking in the constitutional weakness, always present in such cases, of the other voluntary muscles. The spine is disposed to deflect laterally from the median line without any changes in the organic integrity of the bones themselves, though this condition, if permitted to exist for a sufficiently long period, will induce such changes and also permanent curvature.

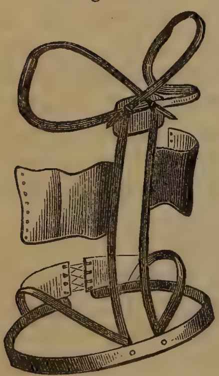
The disease is observed in young persons between the ages of five and fifteen, of a weakly habit of body, and growing rapidly. In these cases the general health will be found to be more or less impaired, the digestive and assimilating functions deranged, and the secretions morbid. These individuals furnish many of the instances of permanent curvature that present themselves at a later period of life. Parents frequently neglect the physical education of their children in their anxiety to develop their mental powers; and the result under the system pursued at the present time in our schools is that any spinal debility that may exist is aggravated by the confinement in the school-room into positive deformity, and such a condition of things is established that months of patient mechanical treatment will be

required to remove curvatures in cases where continuous and early recourse to fresh air, exercise, and a proper diet would have sufficed to restore health and vigor to the system.

From what has been said above, it may be gathered that in case of spinal debility it is of prime importance to attend to the general health, to restore the tone of the muscles by open-air exercise and gymnastics, to improve the digestive and assimilating functions by tonics—iron, quinia, cod-liver oil, cold bathing, &c. Direct the children to abstain from bending the spine laterally over desks in studying and writing, or indeed assuming any fixed posture continuously.

While the constitutional treatment is being conducted upon the above principles, some mechanical support of the spine may be had recourse to. A simple apparatus for this purpose is the one depicted in Fig. 163, consisting of two vertical metallic levers, one upon either side of the spine, connected above with a pad fitting the back between the scapulæ, and taking their point of support upon a padded pelvic strap firmly secured around the hips. From the upper extremities of the levers two axillary supports project beneath the shoulders, each bearing a strap at their points, and intended to pass over the clavicle and scapula, to be buckled to the vertical stems. To confer additional steadiness upon the apparatus, a laced abdominal band is connected with the levers, and another one extends between the pelvic straps across the hypogastrium.

Fig. 163.



Dr. Abbe, of Boston, devised an apparatus to support the spine. It is a wire-gauze frame accurately moulded to the posterior portion of the back, and bound by stout wire. The frame is open at the loins, where a short vertebral jointed stem connects the dorsal and pelvic pieces together; the stem is supported erect by two lateral bands of India-rubber, acting in opposite directions. The apparatus takes its *point d'appui* upon the pelvis, and is secured to the body by two broad bands, one encircling the chest and the other the abdomen, lacing in front, and by two shoulder-straps. The frame is light, exercises uniform pressure, and permits the insensible perspiration to escape freely.

Loss of Functions of the Muscles of the Abdomen. Hernial Bandages.—The abdominal cavity, unlike those of the cranium and chest, is bounded by yielding walls composed of muscular and tendinous structures, and is pierced at points with certain apertures to give egress and ingress to vessels, nerves, and ducts. It is constantly undergoing changes of dimension by their contraction, by which the viscera are subject to a varying degree of compression at all times: during active exertion, particularly, the force is much increased; and should morbid changes or congenital defects have produced alteration in these apertures, the viscera, compressed from every direction, are at this time liable to escape from the abdomen through the orifices, and appear externally under the form of a tumor. The sudden manner

in which this usually takes place gives the impression and semblance of a veritable breaking through or rupturing of the walls, and hence the injury was long ago and is now popularly known as rupture; the more scientific designation, hernia, being derived from the Greek word ἔρνος, a young sprout.

Hernia is distinguished into certain species, according to the locality in which the tumor is located: if at the external orifice of the inguinal canal, it is called inguinal; crural, if at the orifice of the crural canal; and umbilical, when the rupture occurs at the navel. These are the chief varieties of hernia, although there are certain rarer forms, the occurrence of which should be known, caused by the viscera appearing at other points than those above mentioned. They are *ventral*, the tumor being formed over any accidental or natural deficiency in the tendon of the external oblique muscle; *obturator*, the bowel escaping through the aperture in the upper margin of the obturator or thyroid membrane; *ischiatic*, in which the bowel protrudes at the ischiatic notch beneath the gluteal muscles; *perineal*, the tumor being formed in the perineum by the intestine making its way between the bladder and rectum; *vaginal*, produced by the yielding of the wall of the vagina; and *pudendal*, the bowel following the course of the round ligament until it gains the labium major, between its cuticular and mucous layers.

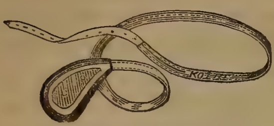
The mechanical contrivance by which this abnormal displacement of the abdominal viscera is sought to be corrected, and, under certain circumstances, cured, is called a hernial bandage, or truss. The general form of a truss is an elastic steel spring covered with buckskin, bearing at its anterior extremity a small pad to make pressure upon the hernial opening, and at the other a larger pad to secure a counter-pressure upon the loins; perineal straps are connected with the pad and spring, to prevent the instrument being displaced during the movements of the person wearing it. The oldest form of a hernial bandage was simply a padded pelvic strap with a large pad, the introduction of the steel spring, in 1781, being due to Mathias Major, since which time both the metallic spring and the pad have undergone innumerable modifications, according to the peculiar mechanical views of surgeons or of manufacturers of the bandages. The pad has sometimes been recommended to be made small and oval, at others large and round; now pyriform, and again triangular. The materials of which it is composed have been equally varied: in some trusses it is composed wholly of metal, ivory, or glass; in others, of soft leather stuffed with horse-hair, floss-silk, fine white sand, or other like materials.

An important feature in the construction of a truss is the manner of attachment of the pad with the spring, In the older instruments above mentioned this was effected by a solid joint which permitted no motion of these parts upon each other, and therefore the person in moving about and constantly altering his attitude caused the pad to slip from over the hernial opening. The way of avoiding this inconvenience is to connect the pad and spring together by a movable joint, several varieties of which have been adopted, as will be seen in the description of the instruments figured below.

The form of the truss must also vary in shape according to the variety of hernia in which it is intended to be employed.

1. In *inguinal hernia,* a truss (Fig. 164) commonly employed in this country, but nevertheless of little merit, consists of a metallic spring immovably attached to its pad and intended to span almost the whole circumference of the pelvis, the interval being made up by a strap perforated with holes to receive a short tenon placed upon the plate of the pad; the pad is oval, convex, and of unequal thickness, the broader margins being at its farther extremity, which rests upon the internal pillar of the abdominal ring, and at its lower border, which should press upon the spine of the pubis to prevent the bowel slipping between it and the pad. This kind of spring and pad is selected that it may control the protruding viscera by pressing upwards, backwards, and a little outwards in the direction of the inguinal canal, which is exactly the reverse direction taken by the intestine in descending to form a tumor exteriorly.

Fig. 164.



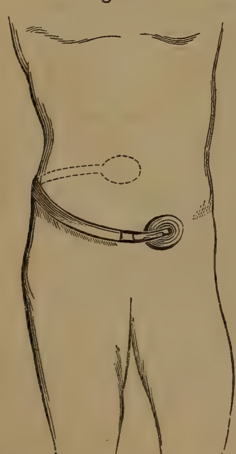
Single inguinal truss.

This instrument is applied upon the side opposite that upon which the hernia is seated.

As there may be two or even three ruptures in the same subject, an additional pad has occasionally been attached to this instrument; but the arrangement is a very bad one, as it produces unequal pressure and is otherwise very insecure.

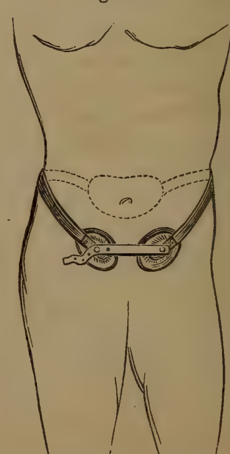
The improvement upon this is to place the two small pads at the extremities of the metallic spring, in double inguinal hernia, for example, and a large pad in its centre to make the counter-pressure over the lumbar region.

Fig. 165.



Salmon and Ody's single truss.

Fig. 166.



Salmon and Ody's double truss.

The objections to the immovable pad already stated were so evident as to lead to numerous attempts to obviate them; and the efforts were

crowned with more or less success. Salmon and Ody introduced a truss (Fig. 165) which has been in high favor for years, and is now extensively employed. It consists of a spring spanning half the body from the spine to the abdominal ring upon the sound side. The pad is oval, and attached to the spring by a ball and socket joint, so that it participates in all the motions of the body, and therefore is not easily displaced. In double inguinal hernia, two pads are fastened in the same manner to the spring which takes its point of support by a broad pad upon the spine. (Fig. 166.)

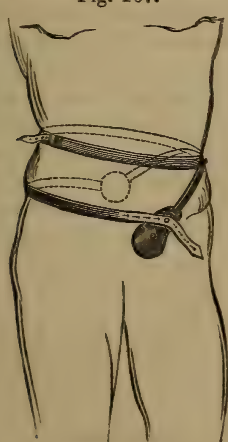
Coles' truss differs from that of Salmon and Ody's, in that the spring extends from the spine to the inguinal ring on that side upon which the hernia is seated; and instead of the ball and socket joint, the pad, which is long and pyriform, is enabled to participate in the movements of the body by means of a flat spiral spring attached to its anterior surface.

Dr. Todd suggested a modification of the spring (Fig. 167) in order to obtain a more energetic pressure upwards and backwards, so that instead of passing around the pelvis as in the two former instruments it mounted over the crest of the ilium and terminated in a small oval pad.

Wickham has introduced a ratchet-wheel into the composition of the pad, so that by means of a screw the pressure may be increased or diminished at pleasure.

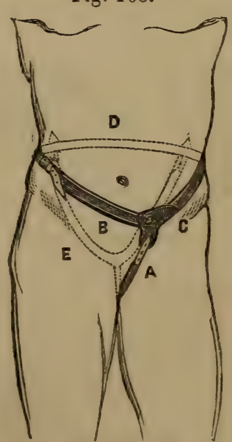
To obtain the same result Dr. Arnott had previously proposed that a chain be attached to the spring along its length capable of being controlled by a key.

Fig. 167.



Todd's truss.

Fig. 168.



Bigg's truss.

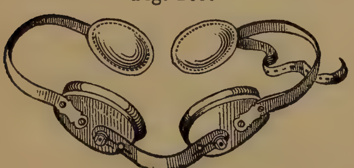
In certain obstinate cases of inguinal rupture, Mr. Bigg, of London, has succeeded in retaining the bowel reduced, by means of a *triple-lever truss* (Fig. 168) which exercises force in three different lines. He explains this kind of an apparatus in the following manner: " A, B, C are three springs of different lengths, moving freely by means

of small staples on the margin of a triangular pad. D is a soft padded leather or silk band passing around the pelvis and containing within it the three springs. E is a silk strap fixed to the lower spring. A, a small button placed in the centre of the pad acts upon the springs, and on being turned increases or diminishes the pressure upon the hernial ring. Owing to the various lengths and positions of the springs each acts in a different direction upon the rupture. A tilts the lower edge of the pad upwards; B acts equally upon the whole surface of the pad, pressing it inwards and upwards; while C acts upon the centre of the pad, forcing it directly inwards. By the combined action of the three springs the tendency of a severe rupture to slip beneath the pad is effectually controlled.

In the truss of Stagner and Hood, improved by Chase and others, the pad is made of birch or cedar, a material possessing lightness and at the same time sufficient closeness of texture as not to absorb the secretions of the part to which it is applied, or to wear out; it is oval in shape and convex upon its ventral surface; and articulated with the spring by a joint which permits the angle formed by it with the spring to be varied at pleasure so as to secure the most perfect adaptation to the surface. The spring is constructed in the usual manner and spans two-thirds of the body, its extremities being joined by a leather strap perforated with holes to be fastened to a button just beyond the pad; the counter-pressure is made by a round pad upon the back part of the spring. When the apparatus is applied in order to prevent its slipping up over the hips, a thigh-strap is attached.

The best truss I am acquainted with, for the treatment of inguinal hernia, is the one seen in Fig. 169, manufactured by the surgical instrument makers of this city and sold under the name of "Hood's truss." It is constructed of two simple trusses connected together by a curved spring spanning the space between the two anterior pads; the posterior pads rest upon the fleshy masses upon either side of the spine, and are connected by a leather strap. When properly applied it is almost impossible, by any movements of the body, to displace this instrument from the position assigned it upon the pelvis and groin. If the hernia is single, but one of the anterior oval plates is then padded, the other is simply covered with buckskin to prevent the skin being chafed; in double hernia, of course, both pads are used.

Fig. 169.



Hood's truss.

Besides the metallic spring truss, there are those in which the elastic force of India-rubber is employed. M. Dupré's hernia bandage is of this description; as it has been found of service in many cases, and is now frequently employed in France, a brief description of it may be acceptable. The frame of the instrument (Fig. 170) is formed of a stout wire, bent to adapt itself to the outlines of the pubis and inguinal regions, and supporting in front one or two pads, according as the hernia is single or double. To the extremities of the arc an elastic

band, furnished with buckles to fasten behind, is attached, and by it the pressure of the pads is regulated at will.

Fig. 170.

Dupré's truss.

A bandage composed entirely of elastic material has been occasionally recommended in the treatment of inguinal rupture. Strips of India-rubber are fastened together in a spiral manner, and their contraction maintains an elastic pad over the inguinal ring. In this manner, M. Bourgeand has devised an apparatus for preventing hernial extrusions, consisting of inflated India-rubber pads, which are confined over the abdominal rings and inguinal canals by a broad elastic band. It is intended to obviate the supposed atrophic effects of the pressure of the pad of the ordinary truss upon the cellular and muscular tissues of the groin, which thereby weakens the part, by substituting the gentle, uniform and effective pressure of an air pad. Another advantage claimed for the apparatus is that the abdomen is gently compressed by the elastic belt, and the intestines thereby effectually supported in their normal site, so that there can be but little disposition on their part to protrusion.

Experience has not confirmed the superiority of Bourgeand's contrivance over the spring truss, and it is therefore now little used. I have employed a modification of it with advantage in the treatment of large irreducible herniæ; giving the air-pad a sufficient concavity to embrace the tumor.

In the moc-main truss the elastic resistance of a spring is employed in the following manner: a padded belt surrounds the pelvis bearing a large oval pad stuffed with floss silk, and having attached to it a short metallic spring. The pad is kept pressed against the inguinal canal by a thigh strap fixed to the end of the spring.

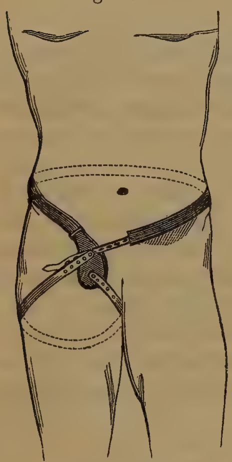
When the viscera have escaped from the abdomen and found their way into the scrotum, forming a moderate-sized tumor, considerable more difficulty will be encountered in keeping the inguinal canal and its rings closed than in simple cases of bubonocele, or where the tumor exists in the groin, and for which the trusses above described are especially adapted.

The action of a truss for oscheocele or scrotal hernia should be to close the entire length of the passage followed by the escaping bowel. The best form of a bandage to effect this will be one with a large fusiform pad supported by a spring encircling the pelvis, and having its lower end firmly held in contact with the parts beneath

by a thigh-strap passing around the thigh opposite the side upon which the hernia exists, and fastening above to the spring. The application of a truss with a large concave pad to an irreducible hernia may in time effect its reduction, but such instruments should be employed with prudence. In some of these instances of large scrotal hernias, irreducible in consequence of adhesions established with surrounding parts, the only mechanical contrivance either advisable or practicable is a simple suspensory bandage which will ameliorate the patient's condition, and enable him to pursue his avocations in life with comparative comfort.

2. *Crural* or *femoral hernia.* The truss (Fig. 171) employed in the treatment of this form of rupture possesses the same general features as that for inguinal hernia, viz: a metallic spring and pad; but, from the fact that the crural ring is inferior and external to the external abdominal ring, the neck of a crural truss must be longer, and the pad must form a less oblique angle with the spring which should always span the diseased side. As the pad, which must be peculiarly shaped, reposes in the folds of the groin, it is apt to be displaced by the movements of the thigh, and therefore a thigh-strap becomes indispensable.

Fig. 171.



Femoral truss.

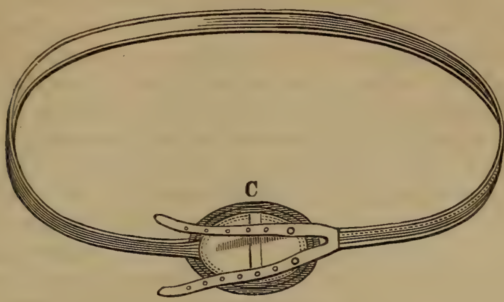
3. *Umbilical hernia* is most frequently met with in infancy in consequence of a tardy closure of the umbilicus during development, and in adults principally among the corpulent. When the viscera have been restored to the abdominal cavity they are, in general, easily retained there by a properly constructed truss, a simple form of which for an infant, or in a mild case in the adult, may be prepared with gum elastic in the shape of a band three or four inches deep and lacing behind. In front, a pad, a little larger than the umbilical opening and slightly convex, is attached to the belt to restrain, by its pressure, the extrusion of the bowel. The size of the pad is an important point in the treatment of this disease; if it is too small, the elastic band or metallic spring (if that is used) is apt to sink it into the opening, and thus defeat the very object that was had in view in employing it.

Should the elastic force of the India-rubber not succeed in restraining the issue of the viscera, then recourse must be had to a metallic spring encircling the body (Fig. 172) and attached to a compressive pad in front. An irreducible umbilical hernia may be benefited, and in time rendered reducible, by constructing the anterior pad with a concave ventral surface which is gradually to be diminished in proportion to the lessening size of the tumor under the pressure, until a convex pad may be employed.

If no well-constructed pad is at hand, as those above mentioned, a simple leathern or elastic belt having an oval pad, or, better still, an

air pad, attached to its middle, will answer as a substitute for them, and will do good service.

Fig. 172.



Umbilical truss.

4. *Ventral hernia* may be treated with the same instruments as those used in the umbilical form of rupture, modifying them, of course, to suit the necessities of individual cases.

5. *Obturator* or *thyroid hernia*, occupying, as it does, a position beneath the ramus of the pubis, may be effectually kept reduced by a truss similar to one adapted for inguinal hernia, with the difference that its neck should be more elongated and the pad smaller, more convex, and oval.

6. *Ischiatic hernia* is more difficult of management, but is yet capable of being controlled by a truss formed of an elastic spring to encircle the pelvis, and an oval pad to rest on that part of the gluteal region corresponding with the ischiatic notch.

7. *Perineal hernia* requires a truss of rather peculiar construction consisting of a padded pelvic strap, from the posterior and central part of which a curved metallic spring projects as far as the tumor, and bearing upon the extremity a firm oval pad to exercise compression upon the protrusion.

8. *Vaginal hernia* can be most effectually treated by properly constructed pessaries, an account of which will be found further on.

9. *Rectal hernia*, resembling vaginal rupture in occurring in one of the natural canals of the body the walls of which form the sac containing the displaced intestine, like it, also requires pessaries, the proper form of which will be seen in a subsequent section.

10. *Pudendal hernia*, formed by the bowel following the course of the round ligament in the inguinal canal, is the analogue of inguinal rupture in the male, and requires for its treatment the inguinal truss already described.

Application of Trusses.—It is of the first importance to secure a properly made hernial bandage for each individual case under treatment, and for this purpose the surgeon should take the necessary measurements of the pelvis of the patient. This may be done with a simple tape measure, placing its extremity upon the hernial tumor and carrying the line horizontally around the pelvis upon the same side to the spine, and noting the number of inches, which will be the

length for the spring. A better way, however, if it is practicable, is to take the measure with a piece of wire, which will give at the same time the contour of the hip. A great deal of injury has been perpetrated by the vendors of ready-made trusses, who sell their instruments indiscriminately without regard to the condition of the patient, or their adaptation to the parts to which they are to be applied: and thus a person, lulled to a sense of security by the fact of his having on a truss, without considering its efficiency, may become suddenly a victim to strangulation by indulging even in an ordinary degree of exertion; a result that would not have taken place at all, had he attended to this point and secured a really good instrument.

The surgeon having procured a properly fitting truss, proceeds to apply it by placing the patient in a horizontal position, and when the entire contents of the hernial sac have been returned into the abdomen, he places the first two or three fingers of the left hand upon the ring and prevents their descent, while with the right hand the truss is unfolded and slipped around the pelvis, the compressing pad being gradually brought over the ring as the fingers are withdrawn. The straps are then to be secured immediately, and the patient directed to rise and move about, to cough, and change his position, while the surgeon makes sure that all is secure by a careful examination. But if the bowel should descend, the truss must be manipulated anew until a complete retention is secured.

For the first few weeks, perhaps, the patient may feel a little annoyance from the truss; this will speedily disappear if the spring is not too strong, a circumstance that may be known by the pad not leaving a depression in the part beneath it. The only amount of pressure, either required or advisable, is that just sufficient to prevent the intestine escaping from the abdomen: this important point is sometimes overlooked, and the result is, that with such stiff truss-springs as are often furnished, inflammatory swelling of the testicle and scrotum, varicocele, excoriation of the skin, and absorption of the tissues compressed, are some of the accidents liable to follow their use. The spermatic cord must also be carefully exempted from injurious pressure of the pad. The truss is essentially a palliative instrument in patients beyond the 18th or 19th year; but in children it is generally successful in obliterating the canal; and, faithfully employed, will effect a cure in from twelve to eighteen months. In adults this result is rarely obtained, even after years of perseverance with the use of the truss: the only advantage accruing from its employment, though that is a very important one, is the retention of the abdominal viscera in their natural cavity, and freedom from the chance of their becoming strangulated.

The instrument must be worn constantly, day and night; and it will be well, during any unusual exertion, violent coughing, sneezing, and the like, to support the pad with the fingers. During warm weather, to prevent excoriation, it will be advisable to interpose between the pad and the skin a fold of soft linen. Some persons are in the habit, occasionally, for the same purpose, of wearing the truss over an under-garment, a plan which cannot be too strongly condemned, for the rea-

son that the pad is thereby constantly liable to be displaced, and to permit the bowel to escape.

THE TAXIS.—The reduction of hernia by manipulation is technically called taxis. As there are certain general rules to be observed in employing the taxis in the different kinds of hernia, a cursory allusion to them in this place will save further repetition when we come to consider each variety separately.

Position.—The best position to place the patient in to obtain as perfect a relaxation of the muscles as possible, is the horizontal, with the hip elevated, and the thighs somewhat flexed. Some persons prefer to place the patient upon a sofa, with its end sloping upwards, over which his legs hang, while his head rests upon its centre, in a lower plane than the rest of the body. Although the position of the patient will contribute much towards relaxing the muscles, there are other adjuvants still more potent.

Anæsthetics.—It was formerly the custom to produce muscular relaxation by the warm bath, the administration of tartar emetic, injections of an infusion of tobacco, and copious venesection; but the discovery and introduction of the anæsthetics in surgery have well-nigh rendered the use of these agents obsolete, though under circumstances where chloroform or ether are not attainable, these means may be had recourse to, and will prove of service. It has, also, been recommended that cold be applied to the scrotum to contract and to condense the contents of the sac for facilitating their return. Powdered ice, wrapped up in a piece of oiled silk, or cold water, applied to the bottom of the tumor, will be as good a plan as any to obtain the physiological action of cold.

In the application of compression, which requires the greatest discretion as to its amount, duration, and direction, it must always be borne in mind that, although the taxis will often succeed in accomplishing the reduction of the hernia, there are numerous cases in which it will fail, and herniotomy is required; then the future welfare of the patient as to his chance of surviving will depend, to a great extent, upon the amount and character of the manipulation to which the intestine has been subject in the taxis. The amount of compression that may be prudent, without jeopardizing the subsequent well-being of the patient, should the taxis fail, and an operation become necessary, may be exercised by seizing the hernial tumor in the palm of the hand, and with the fingers, knead gently the part, until its contents give the sensation of uniformity, when gentle traction should be made upon it to draw down the intestine a little to disengage it from the ring. Then the pressure of the hand must be exercised upon the tumor at every part embraced, so that the upper portion of its contents alone may press upon the ring, while the fingers of the opposite hand are employed in pressing the intestine, little by little, through the ring in an appropriate direction. If the whole tumor is compressed directly against the ring its contents will spread out over it, and frustrate the surgeon's efforts.

The duration of the compression should not be too long, as the case becomes more and more grave with the duration of the strangulation,

and the chances of success of herniotomy diminish in a direct proportion. After the patient has been fully etherized, and taxis employed judiciously, for a period longer or shorter, according to the circumstances of the case, and the reduction cannot be accomplished, another trial may be made in a few minutes, by changing the patient's position, or having recourse to another method of taxis than the one at first tried. Should this in like manner fail, the surgeon had better suspend his efforts, and subject the patient to herniotomy without delay.

The direction of compression must vary in the different forms of hernia, and will, therefore, be considered further on.

In applying the taxis it will be advisable to endeavor to ascertain the character of the contents of the hernial sac by a careful examination, so that the parts may be reduced in the reverse order of their extrusion; that is, intestine first, and then omentum. The constituents of a hernial tumor may be defined to a certain extent by its physical characters. The descent of the bowel containing gaseous matter (enterocele) will produce a tumor more or less elastic, smooth, and uniform to the touch, and is usually larger, more sensitive, and more easily reduced than one containing omentum only, the reduction taking place suddenly, and accompanied by a peculiar gurgling noise. The presence of omentum in the tumor (epiplocele) confers upon it an irregular, soft, and doughy feel; and the reduction takes place slowly and without noise; it is usually smaller than an enterocele. When the hernial protrusion contains both intestine and omentum (entero-epiplocele) it will partake, in a measure, of the characteristics of both the preceding varieties, a part of it feeling elastic, while the other is doughy.

1. *Taxis of Inguinal Hernia.*—As already stated, inguinal hernia is formed by the intestine escaping at the external abdominal ring, and it is said to be indirect or external, when the bowel enters the internal abdominal ring and courses the inguinal canal, and direct or internal when it escapes by forcing before it the conjoined tendon of the internal oblique and transversalis muscles. In the former case the direction will be downwards, inwards, and forwards, and in the latter forwards and downwards. The terms internal and external inguinal hernia refer to the position of the neck of the sac, as regards the epigastric artery. If the protruding viscera are arrested in the groin, the hernia receives the name of bubonocele, while it is designated oscheocele when they are contained in the scrotum.

In using the taxis in inguinal rupture, the patient should be placed in the position indicated above, to relax the abdominal muscles as thoroughly as practicable, and then be completely anæsthetized. The surgeon takes his position upon the side of the patient upon which the hernia is, grasps the tumor in the palm of one of his hands and compresses it to diminish its bulk, while with the fingers of the other hand placed over the external abdominal ring, he endeavors to press the contents of the upper part of the tumor into the abdomen, little by little, until the whole of the displaced viscera shall have been restored to their natural cavity. The pressure must be exercised in

indirect hernia upwards, a little backwards and outwards; while in the direct variety the line of pressure ought to be upwards and backwards. In long-standing cases of indirect rupture, the two rings are drawn more or less into the same line, so that the manipulation in these cases will have to be modified, so that the pressure may bear upwards and almost backwards, as in direct hernia. Generally, as soon as the constricted portion of the intestine is replaced, the remainder will slip in immediately.

A plan for the taxis, as recommended by M. Després, in small inguinal hernia, is thus described by Jamain: The surgeon applies the cubital border of the left hand a little above the pedicle (or neck) of the hernia, strokes it in such a manner as to draw the tumor into the scrotum; then compresses the tumor with the right hand more or less firmly, according to the volume of the hernia; and the hernia enters, after some efforts, of which the surgeon regulates the intensity and duration.

This is the way M. Després explains the mechanism of this process: 1. He fixes the neck of the sac, the principal obstacle to the reduction. 2. In pressing upon the tumor he diminishes the volume of the intestine at the orifice of the sac. 3. In pressing with the right hand he causes the intestinal loop to execute a movement analogous to that of two fingers opening a purse.

Dr. Wise, of India, describes in the London *Journal of Medicine* the following way of making the taxis, which he states to have been followed by success: "Place the patient on a table, and having folded a long sheet several times on itself, carry it around the lower part of his pelvis, twisting it on itself, in front and again at the sides, so as to enable the assistants, who stand on each side to hold the extremities of the sheet, and pull them gently upwards or towards the patient's head, while a third assistant holds the feet, and the surgeon makes the taxis. As the gut immediately above the strangulated portion is often superficial, and distended with flatus and liquid, it will be drawn upwards from the hernial sac, whilst the return of the protruded portion is favored by the taxis practised by the surgeon."

I have succeeded in reducing two cases of strangulated inguinal hernia by a mode highly recommended by M. Seutin. It is effected in the following manner: "The patient is laid upon his back, with the pelvis raised much higher than the shoulders, in order that the intestinal mass may exert traction upon the herniated portion. The knees are flexed, and the body is slightly turned to the opposite side to that on which the hernia exists. The surgeon ascertains that the hernia, habitually reducible, cannot be returned by continuous and moderate taxis. He next seeks with his index finger for the aperture that has given issue to the hernia, pushing up the skin sufficiently from below in order not to be arrested by its resistance. The extremity of the finger is passed slowly in between the viscera and the herniary orifice, depressing the intestine or omentum with the pulp of the finger. This stage of the procedure demands perseverance, for at first it seems impossible to succeed. The finger is next to be curved as a hook, and sufficient traction exerted on the ring to rupture some of the fibres, giving rise to a cracking very sensible to the

finger, and sometimes to the ear. When this characteristic crack is not produced, the fibres must be submitted to a continuous forced extension, which, by distending them beyond the agency of their natural elasticity, generally terminates the strangulation. This mode of procedure is less applicable to Gimbernat's ligament, the hooking and tearing of which are more difficult than in the case of the inguinal ring. Considerable strength has sometimes to be exerted, and the index finger becomes much fatigued. When, in consequence of the narrowness of the ring, the finger does not at once penetrate, it is to be pressed firmly against the fibrous edge, and inclined towards the hernia. After a time the fibres yield and the finger passes. When the finger becomes fatigued it is not to be withdrawn, but it should be supported by the fingers of an intelligent assistant, who seconds the action it is desired to produce. In inguinal hernia, the traction should not be exerted with the finger upon Poupart's ligament, but in a direction from within outwards, and from below upwards, by which the aponeurotic layers between the two ligamentous pillars constituting the inguinal aperture are easily torn through.

"The ring is then enlarged by this tearing, just as if it had been divided by a cutting instrument, or largely dilated, and reduction takes place easily by performing the taxis in a suitable direction."

Care should be taken that the whole mass of the hernia may not slip into the abdomen while the constriction remains unrelieved. If the accident should result, the patient should be directed to make straining efforts to reproduce the hernia, when the taxis may be again had recourse to; if this be not successful, herniotomy alone remains to be performed, and this is then often followed by a fatal result.

After the successful employment of the taxis in inguinal hernia, the patient should be kept in the horizontal position a few days, and an appropriate truss applied.

2. *Taxis of Crural Hernia.*—The intestine passing through the femoral canal and saphenous opening in the fascia lata will form a tumor of smaller size than that observed in inguinal hernia, with its greater diameter transverse, and located at a point somewhat lower and a little external to the external abdominal ring. By placing the finger upon the horizontal ramus of the pubic bone the tumor will be found to be situated below it.

From the peculiar conformation of the crural canal, in performing the taxis it will be necessary to place the patient in the horizontal posture, and in order to relax the parts about the internal femoral ring and saphenous opening, flex the thigh upon the abdomen, adduct and rotate it inwards. Then the surgeon, having thoroughly anæsthetized the patient, he takes his place upon that side of him opposite the one upon which the hernia is situated, and grasps the tumor, if it has appeared above the falciform process of the saphenous opening, with the hand lying in the axis of the thigh, presses it downwards and a little inwards, until the intestine enters the infundibulum, when with the fingers of the other hand pressure is exercised upward and a little outward. Of course, if the intestine is found still in the infundibulum

when the case is first seen, the latter part of this movement is only required, that is, pressure upwards and a little outwards.

Crural hernia requires more caution in manipulating the reduction than the inguinal, in consequence of the firm and resisting nature of the fibrous barriers through which the intestine passes to the exterior; and more injury is therefore likely to follow the efforts to force it in a retrograde direction. For this reason the time employed in making the taxis should be much shorter.

From the shortness of the omentum and the lower position of the crural canal, the tumor will be found most often to contain intestine. When the reduction has been accomplished, a properly constructed truss must be applied.

3. *Taxis of Umbilical Hernia.*—The manipulations required to return the extruded intestine in this variety of rupture are much more simple and less dangerous than in either of the two preceding varieties, for the reason that the point of issue is a simple aperture in the abdominal walls instead of a canal with sharp and resisting boundaries.

Umbilical hernia occurs most frequently after birth, the aperture through which the vessel of the child passes to gain admission into the abdomen not being closed; in the adult, it happens in a majority of cases in obese subjects.

In employing the taxis, the surgeon takes the tumor in the palm of his right hand, and, having diminished its size by compressing it, with the fingers of the other hand at the umbilicus he makes compression directly backwards, until he may have effected the return of the contents of the hernia. If, from the size of the tumor or other causes, the bowel has descended below the umbilical ring, pressure will have to be made upwards and then backwards. When the reduction has been effected, one of the trusses already described must be applied.

Loss of Function of the Sphincter Ani. Prolapsus Ani.—This prolapse occurs both in infancy and in the adult, the former variety being much more amenable to treatment by mechanical means than the latter. It consists in its mildest form of the extrusion of the rectal mucous membrane beyond the sphincter, forming a globular shaped and transversely corrugated tumor; in cases of long standing, not only the mucous membrane but the muscular walls of the gut itself become prolapsed. In a case now under my treatment this condition of things exists, accompanied with so great a relaxation of the sphincter ani that the whole hand can be introduced into the rectum with ease.

Replacement of the Prolapse.—In the first class of cases mentioned, or those occurring in infancy, the reduction is easily accomplished by simply oiling the index finger and pressing upon the centre of the tumor, when the bowel will gradually recede within the sphincter. In large prolapses, when the above plan will not succeed, the patient may be placed upon his knees with the head supported by a pillow so as to give the pelvis a greater elevation than the rest of the body, and in order that the abdominal viscera may gravitate towards the diaphragm; then the surgeon, having washed the tumor, greases the ends of his first three fingers, places their tips upon the centre of the tumor, and

presses the bowel within the sphincter; or the patient may be placed upon his side with the thighs drawn up and the body flexed forwards so as to relax the abdominal muscles, and anæsthetized, when the above manipulation with the fingers may be practised.

Retentive Apparatus.—The simplest form of a mechanical support that can be employed in mild cases of prolapse is to place, after the reduction of the bowel, a slightly convex pad over the sphincter, of sufficient size to extend beyond its margins, and secured by a T bandage. Some surgeons recommend the introduction into the rectum of an ivory or wax pessary to support the folds of its mucous membrane until they gain sufficient tone to resist extrusion.

Fig. 173.

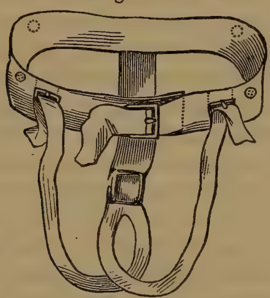


Fig. 174.

Apparatus for prolapsus ani.

A more elegant method of making compression upon the sphincter is with an apparatus (Fig. 174) consisting of a well-padded belt for the loins, from the centre of which belt there projects posteriorly a flat spring bearing at its extremity a slight convex pad firmly stuffed with fine sand and covered with smooth buckskin, or a metallic plate with an India-rubber air-pad secured upon its upper surface of sufficient size to repose upon the margins of the sphincter.

In the inveterate case above mentioned, under my care, I employed an apparatus composed of a loop of No. 6 wire, four inches long, and curved to fit the anterior surface of the sacrum, having a stem at its base an inch and a half long, and formed of the two wires of the loop twisted together. The end of this stem was soldered to a wire frame consisting of a single wire crossing the perineum antero-posteriorly, and dividing in front and behind into two branches terminating in large eyes, through which a cord was passed to secure the apparatus to the person. By this means the bowel was retained in its normal situation during defecation, by the instrument holding the posterior wall of the rectum against the curve of the sacrum.

Loss of Function of the Uterine Ligaments and Vaginal Walls. Prolapsus Uteri.—There are two kinds of mechanical supports employed for the correction of prolapse of the uterus: the one internal, designated pessaries, a name derived from the Greek πεσσο, and supposed by some to come from πεσσειν, "to assuage," by others from πεσχος, the skin of an animal with hair upon it, in which the materials of a pessary were formerly inclosed before being intro-

duced into the vagina; the other external, and commonly called uterine supporters.

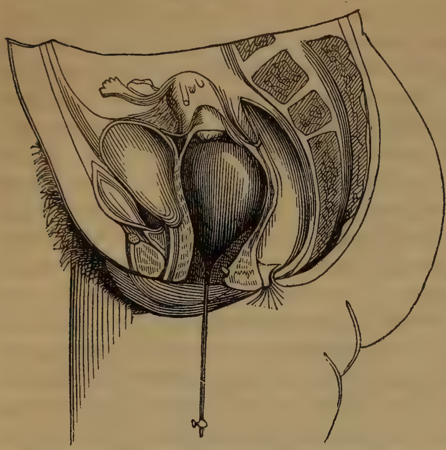
1. *Pessaries.*—In former times pessaries were composed of various medicinal substances, and were introduced into the vagina with a view of obtaining their specific effects upon the mucous membrane; astringent articles being frequently employed in this manner; no stress was laid upon their use as mechanical supports; but at present they are especially designed to obtain this object, and are prepared of such resisting materials and of such volume as to offer a mechanical obstruction to the displacement of the uterus by taking points of support upon the vaginal wall and perineum, or they are sometimes supported by the aid of an exterior bandage. The material and shape of pessaries have within the last two hundred years undergone innumerable modifications; those employed at the present day are manufactured of hard wood, certain of the metals (gold, silver, steel, iron wire), gutta-percha, gum-elastic, sponge, cork, &c. The shape is equally as various —globular, oval, discoid, conical, and horseshoe-shaped.

Pessaries which take their points of support internally.—The instruments of this class enjoy a high reputation and are much employed in America. A simple pessary of this class consists of an oval or round discoidal-shaped instrument made of gutta-percha or boxwood, and perforated in the centre with a hole for the escape of the menstrual secretions, and which may also permit of impregnation taking place. This is introduced into the vagina by pressing the pessary held in the fingers of the right hand vertically, against the vulva while the left index-finger depresses the perineum, and then bringing it into a transverse position by pressing upon its edge so that it may catch upon each side of the vagina in the direction of the ischia. The instrument is liable to three objections: first, it cannot be manipulated so readily by the female herself; secondly, if the aperture in its centre is made too large, the neck of the uterus may pass through it and become strangulated (the latter objection may, however, be easily remedied by having the hole made too small for this part of the uterus to pass); thirdly, it is supported by a narrow band of the vagina, and is therefore easily displaced.

Zwanck, of Hamburg, has successfully overcome these objections by a discoid pessary composed of two hollow and oval pieces of metal, united by a hinge which is moved by a curved stem connected with each disk. The instrument is introduced closed; then by bringing the two stems together, and fixing them by a screw at their extremities, the disks are expanded. This pessary is well adapted to the severer cases of prolapse.

Cloquet employed what he denominated an elytroid pessary, prepared in exact imitation of a model of the vagina, with the uterus in its normal position, taken with plaster of Paris. The instrument has a compressed cylindroidal form, concave anteriorly and convex posteriorly, to fit exactly the curve of the sacrum. Its upper extremity is concave, with its longest axis transverse; its lower expands laterally into two wing-shaped processes; a canal runs its entire length, to give

Fig. 175.



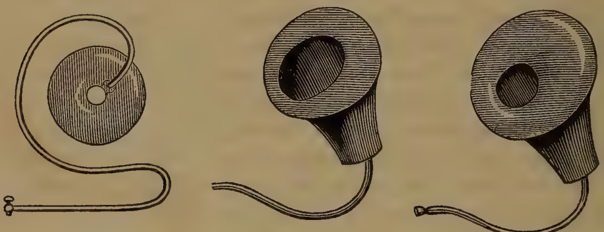
Mode of introducing the India-rubber pessary.

issue to the menses. It is supported in the vagina by the expanded lower extremity catching upon the inner surface of that canal above the labia majora.

An elegant form of pessary, now coming into general use and possessing many advantages, consists of a ball of India-rubber connected with a tube of the same material about six inches long. This instrument (Fig. 175) is first emptied of air by pressing it in the hand, then introduced into the vagina and inflated by means of a second ball, of somewhat larger dimensions, also of India-rubber; the air is prevented from issuing again by closing a little stopcock at the end of the tube.

The shape of the pessary may be varied, as may be seen in Figs. 176, 177, and 178, and constructed with a central canal for the issue

Fig. 176. Fig. 177. Fig. 178.



Different forms of India-rubber pessaries.

of the menstrual secretions; but as it is intended that the ball should be removed every night and cleansed, very little, if any, advantage is obtainable from these modifications.

The India-rubber ball, presenting a large surface, comes in contact with a greater area of the vaginal walls, and therefore is better supported by them, than any other kind of pessary.

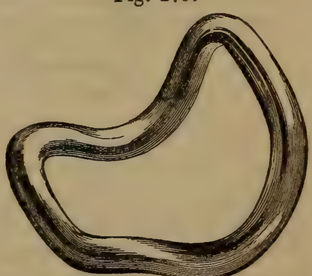
The softness and elastic nature of this material certainly produce the minimum amount of irritation that any instrument of the kind is capable of causing. An additional advantage is also presented in that the patient herself can introduce and remove the pessary whenever she chooses, for vaginal ablutions, which should be sedulously practised every day, to prevent the lodgment of acrid or irritating secretions, or for other purposes; there is no danger of her giving it a false position, nor does it require any skill to put the pessary in its proper place, two important circumstances which confer upon it a

decided superiority over other instruments. It is particularly adapted to prolapsus of the third degree, when there is a large vagina and much relaxation of the surrounding parts.

M. Diday employed this instrument successfully in plugging the vagina in uterine hemorrhage. Its advantages, according to him, are: "1. In its simplicity, and the rapidity with which it may be employed. Thus, it only weighs about half an ounce, is soft and flexible, admitting of being put in the instrument-case, and is applied in a few seconds. 2. It causes no pain, either during or after its application, and requires no bandage to retain it. 3. It admits, before insufflation, of being moulded on the parts to be compressed, and thus can exert compression upon a cavity, however irregular in form. 4. It allows of any degree of diminution or increase of pressure to be made, according to the exigencies of the case. 5. It is impermeable to and incorruptible by whatever discharges it comes into contact with, and never loses its elasticity. 6. Distended only to a third or fourth of its natural extensibility, it is just as smooth, and possesses nearly as great a resisting power, as when fully distended. 7. A somewhat larger apparatus would be available for plugging the cavity of the uterus itself, in hemorrhage after delivery. Moulded on the inner surface of that organ during its state of inertia, as this became recovered from, the air would be gradually let out, and the size of the compressing vessel diminished *pari passu* with that of the uterine cavity."

Dr. Hodge, of Philadelphia, recommends a pessary composed of gutta-percha, and shaped as seen in the figure (Fig. 179). One of the shorter sides is introduced behind the cervix uteri when the instrument is placed in the upper part of the vagina. From the peculiar shape of the lateral sides (that of the Italic letter *s*), the instrument is stated by him to possess the power of a lever, and, besides supporting the uterus, throws the fundus forwards, should it be displaced in retroversion. Before the pessary is introduced, it must be well oiled; and the forefinger of the left hand of the surgeon being placed upon the fourchette, to depress the perineum, the instrument, held in the right hand, is presented to the vulva by one of its narrow ends, its width corresponding with the antero-posterior axis of the vulva, and is pressed gently in the vagina, and then twisted upon itself a quarter of a circle, until it lies transversely with its superior cross-piece fairly lodged in the *cul-de-sac* behind the neck of the uterus.

Fig. 179.



Closed lever pessary.

Sponge has been employed as a pessary, and is either placed immediately in the vagina, or protected with a covering of linen or oiled silk; its advantages are cheapness, facility of putting it in place by the woman herself, and its immediate expansion supporting the uterus in its normal site. The disadvantages, however, of the material more than counterbalance these advantages; it irritates the vaginal mucous

membrane, absorbs the secretions, and in consequence becomes rapidly foul. If used at all, it must be restricted to slight cases of displacement, and must be removed every twelve hours to be thoroughly soaked in hot water and cleansed; two or three pieces of the sponge may be thus used alternately.

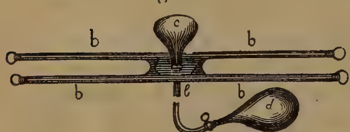
Bauhin employed pessaries of silver wire, and Prunel those of iron wire made in the shape of the frustrum of a cone, and rendered elastic by a series of superficial rings joined together, and covered with soft leather. M. Mayor extemporized pessaries consisting of a framework of iron wire, covered with carded cotton and oiled silk.

Pessaries which are supported by an external bandage.—One of the oldest forms of this class of pessaries is the common bilboquet, which is an instrument shaped at its superior extremity to receive the cervix uteri, and terminating below in a stem to which is attached the straps to be fastened above to a pelvic belt. This method of supporting a pessary is liable to the objection that the movements of the patient displace more or less the pelvic belt, and thus urge the instrument against the os uteri.

This pessary may be still further modified by constructing the stem hollow, so that the menstrual and mucous secretion may escape externally.

An apparatus (Fig. 180), constructed by M. Gariel, deserves to be especially mentioned; it is intended for severe cases of prolapse, attended with rupture of the recto-vaginal septum, when some external support becomes indispensable. It consists of an India-rubber pessary (*c*), fixed to the middle of a perineal band, which is supported in place by four thigh-straps (*b*, *b*, *b*, *b*), formed of rubber tubes fastened to a pelvic band.

Fig. 180.



Gariel pessary.

An aperture is made in the perineal strap, that the patient may micturate without displacing the bandage.

These forms of the pessary are sometimes employed in connection with a broad abdominal bandage.

2. *Uterine Supporters.*—In Europe, the tendency is to do away with internal uterine support in prolapse, and to substitute compression, with a bandage upon the sacrum, hypogastrium, or perineum. Dr. West remarks, in regard to instruments of this class: "One source of comfort to the patient, from the employment of some external supports, is derived from the counter-pressure on the pelvis which the belt exercises, and which relieves very many of the painful sensations experienced in cases of uterine prolapsus. The bandages which seem to me extremely well adapted for this purpose are Hull's utero-abdominal supporter, and a bandage known by instrument-makers as Dr. Ashburner's bandage. Each of them tightly embraces the hips, while the former is furnished with a large padded metallic plate fitting over the pubis, and the latter with a similar one adapted to the upper part of the sacrum. The chief utility of these metallic plates is that by their firm and yet gentle counter-pressure they relieve the sympa-

thetic pains referred to the back in one case, or the dragging and distress in the region of the ovaries in another. To both of them a strap passing between the legs, with a perineal pad, is adapted; and though it can be dispensed with at pleasure, will be found of great service in all cases of considerable relaxation of the vagina, with disposition to

Fig. 181.

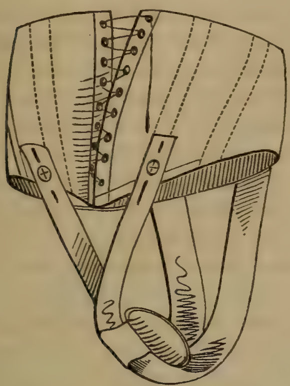


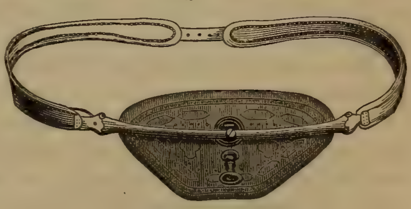
Fig. 182.

Uterine supporter. Front and back view.

actual procidentia, when used either alone or in combination with some form of internal support. The strap and perineal pad have the disadvantage of heating the parts, and thus of keeping up leucorrhœal discharge; but without them the instrument cannot be so well adjusted. Of the two, that of Dr. Ashburner, with its sacral pad, has seemed to me the more useful, greatly relieving the back-ache, and being found, indeed, by some persons, almost indispensable to their comfort in walking or making any kind of exertion."

In the apparatus seen in Fig. 183, the pad is constructed with a movable plate and ratchet arrangement, controlled by a key, so that the pressure may be graduated to the necessities of each case. The two lateral metallic springs, attached to the plate, are fastened behind by strap and buckle. A much simpler supporter may be constructed after the manner of "Hood's Truss," already described; the anterior pads, which are to rest above the pubis, however, should be larger than in that instrument.

Fig. 183.



Uterine Supporter.

Introduction of Pessaries.—We have cursorily glanced, under the description of each instrument, at the method of introduction required by its individual peculiarities; and therefore a few general remarks, applicable in these respects to all of them, will be required in this place.

The position that a patient should take while a pessary is being

introduced, may be one of recumbency upon the back or left side, with the legs flexed and the thighs drawn up so that the abdominal muscles shall be placed in a state of the most perfect relaxation possible. Then the uterus having been pressed into its natural site, the surgeon greases the pessary thoroughly, and gently presses it into the vulva, and as high up into the vagina as the cul-de-sac behind the os uteri, where it is retained, if of the proper size, by the contractile power of the vagina alone. From an unusual sensitiveness or irritability of the part, a sufficiently large instrument cannot be introduced at first; but one of smaller dimensions will have to be selected and used until the canal becomes accustomed to its presence, when it may be replaced by a still larger one. Injections and the hip-bath, with rest in the recumbent posture, will materially aid in enabling the parts to tolerate the foreign body. Inflammation, or any considerable congestion of the uterus, will contraindicate its employment until those have been controlled by appropriate medication.

When the pessary has been put in the position intended, the patient should be directed to move about the room and to cough, in order to ascertain if it will remain fixed, and does not cause pain or uneasiness.

The instrument sometimes causes difficulty in urination or defecation, numbness of the legs, or some pain or unpleasant sensation in the small of the back, requiring the instrument to be changed for another, and the use of emollient injections.

Pessaries, prepared of any material whatever, should not be kept for many days together in the vagina, as a calcareous deposit will take place upon their surface, producing much irritation and even ulceration of the surrounding parts, and they have been known to establish both vesico-vaginal and recto-vaginal fistulæ. Daily ablutions will diminish in a measure this incrustation, and prevent the accumulation of fetid secretions. In some patients they may require removal and washing every twenty four hours, in others every four or five days will suffice; in general it will not be advisable to delay it beyond the latter period.

Should the tone of the vaginal walls and uterine ligaments be restored, and a cure of the prolapse deemed secure, it will be requisite to decrease, by degrees, the size of the instrument, and then gradually abandon its use.

The removal of a pessary is accomplished by placing the female in the same position as we have stated for its introduction, and then with the finger it may be hooked and drawn out; or the loop of a cord may be passed over some part of it and used as a means of traction.

SECTION III.

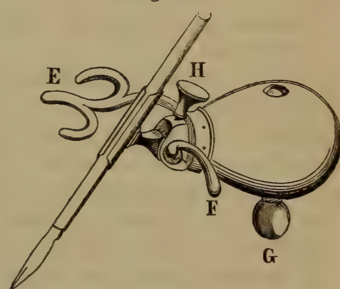
APPARATUS FOR REMEDYING LOSS OF FUNCTION OF PARTS OF THE UPPER EXTREMITIES.

Loss of Function of Muscles of Fingers.—Writer's cramp, sometimes called chorea scriptorum, consists in a spasmodic action of the flexor muscles of the thumb and fingers, which either contract rigidly or irregularly in such a manner that a pen cannot be controlled

in writing, though in all other movements in which the muscles participate no difficulty from this source is encountered. Sometimes the extensor muscles suffer instead of the flexor. This spasmodic action is seen also in other muscles which are directly employed in any particular manner, as those of the leg in turning the lathe, and those concerned in guiding the needle in sewing, printing, fingering musical instruments, &c.

Treatment.—Absolute abstinence from the exciting causes is the only means necessary in certain cases to effect a cure, while others are persistent for weeks or months, or lastly, others again may be incurable. The chances of recovery are greater or less in proportion to the number of muscles affected, as, for instance, where it affects only those of the thumb or of a single finger. More hope of alleviation may also be entertained from the means employed in these cases where the movements habitually executed require the co-ordination of fewer muscles to execute them; the hand of a shoemaker or printer may be relieved by mechanical appliances, which will enable them to resume their avocations; while, on the contrary, the same amount of spasmodic action in the hand of a musician could not be sufficiently diminished by the same apparatus to enable him to pursue his profession. The mechanical apparatus which have been suggested for the alleviation or cure of this remarkable spasmodic action of the muscles of the hand in the classes of persons above mentioned are ingenious. Velpeau invented one (Fig. 184) consisting of an ovoid handle to which is attached a tube for carrying the pen, and two metallic rests for the index and middle fingers.

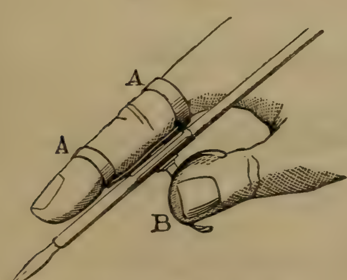
Fig. 184.



Velpeau's apparatus for writer's cramp.

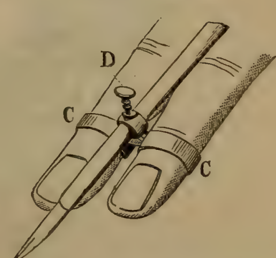
In mild cases, the little instrument seen in Fig. 185 will be of essential service in restraining the abnormal contraction of the muscles. It is simply a pen holder supported between the rings A A fitting on the index finger and the thumb-piece B.

Fig. 185.



Apparatus for writer's cramp.

Fig. 186.



Apparatus for writer's cramp.

To relieve the muscles of the thumb entirely, the pen may be sup-

ported by the index and middle fingers only. This may be conveniently effected with the contrivance seen in Fig. 186; it resembles the frame of a pair of spectacles, the rings of which, C C, fit over the tips of the index and middle fingers; between them there is a third ring to support the pen which is clamped in it by the thumb-screw D.

Others have endeavored to antagonize the muscles by springs and India-rubber cords, or to restrain their abnormal action by making pressure upon them with a sort of mitten woven of rubber and silk. The same result may be obtained by two accurately moulded splints to the radial and ulnar sides of the hand and connected together by an elastic band.

Cazenave invented an apparatus consisting of a penholder armed with two compressing screws, and two circles of India-rubber, each provided with a return screw.

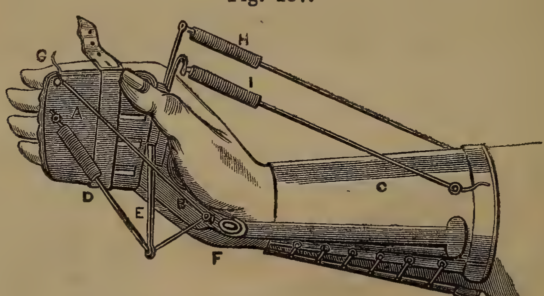
In the absence of more perfect apparatus, relief will be derived from simply fixing an ordinary penholder upon the fingers with a ribbon.

Sometimes continuous pressure exercised upon the arm by a laced bandage will be followed by an alleviation of this distressing disease.

Loss of Function of the Interossei Muscle of the Fingers.—A result, sometimes observed of the action of lead poison, or of some injury, is to cause a paralysis of the interossei muscles of the fingers, which then assume that peculiar position which has been called by French surgeons "main au griffe." The first phalanges are extended upon the metacarpal bones, by the common extensor not being antagonized, while the second and third phalanges are drawn down or flexed upon the first in such a manner as to resemble the claw of a bird.

After the removal of the cause, whatever that may be, upon which this disease depends, by appropriate medication, electrization, &c., the restoration of the functions of the affected muscles may be materially assisted by mechanical means.

Fig. 187.



Apparatus for paralysis of the interossei muscle.

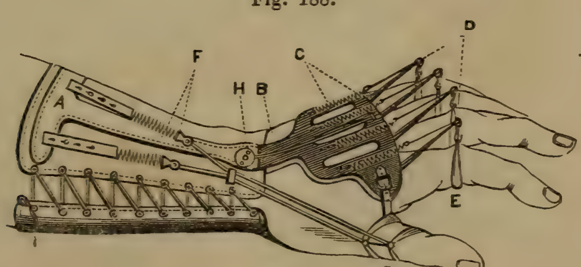
For this purpose M. Duchenne has invented the following very ingenious piece of mechanism (Fig. 187).

A metallic stem is secured to the anterior surface of the forearm by a laced wristlet, C, its lower extremity is articulated to a plate B, fitted to the palm, by a joint F, admitting lateral motion only; a second metallic

plate A, with four grooves, is jointed to the first with ginglymoid motion, and intended to be applied to the palmar aspect of the fingers, to which it is fastened by a strap passing across their dorsal surface. To the lower edge of this piece a spiral spring D is attached by one of its ends; the other end has a gut cord fastened to it, which, after running through a hole in the top of a metallic pin little more than an inch long, and erected upon the palmar plate, passes through a ring near the articulation at the wrist, and is then reflected to the lower radial corner, G, of the second plate, to be tied to a hole placed there for this purpose. From the outer border of the palmar plate two metallic stems also project, and are each supplied with a spiral spring H, I, and a catgut cord, the latter intended to be fastened to two little button-like projections placed respectively upon the posterior and anterior aspects of the upper portion of the wristlet. The action of the apparatus is simple; the articulation of the wrist-stem with the palmar plate keeps the hand extended, and permits abduction and adduction to be exercised by the two lateral springs and gut cords. The second or digital plate serves the purpose of a splint in keeping the fingers straight, and permits their flexion by its moveable connections with the palmar piece, and is under the control of the spring and cord passing over the pulley in the palm.

Loss of Function of the Extensor Communis Digitorum.—Paralysis of the common extensor of the fingers sometimes results from the impregnation of the system with lead, and is characterized by the inability of the patient to extend the first row of phalanges upon the metacarpus; the flexors of the fingers being unopposed contract, sometimes so energetically as to produce almost a subluxation of the metacarpo-phalangeal articulations. As shown in wrist-drop, if the disease has been of long standing and the muscles atrophied, very little benefit can be expected from any plan of treatment, either therapeutical or mechanical. A number of apparatus have been suggested by surgeons to remedy this distressing condition. Of these none possess more merit than the one employed by that ingenious and learned physician M. Duchenne, of Boulogne (Fig. 188), constructed after the model of an

Fig. 188.



Apparatus for paralysis of the extensor communis.

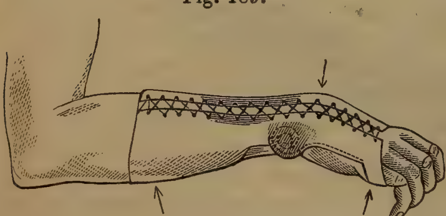
apparatus originally devised by M. Delacroix, and described by M. Gerdy. It is composed of a laced wristlet, to which is attached a metallic plate A, fitting the posterior and lower part of the forearm; to the inferior extremity of this another plate, B, is articulated by a joint H,

working laterally, moulded to the dorsum of the hand, and secured by a strap crossing the palm; to make it lighter and to permit the insensible perspiration to escape, three fenestræ are made parallel with its length. Four short stems, somewhat raised from the fingers, are soldered to the lower edge of the dorsal plate, furnished with little pulleys over which gut cords D play, connected at one extremity to spiral springs C attached to the plate, and at the other to four little rings E encircling the fingers at the second phalangeal joints. Two other spiral springs, F, are fixed to the forearm plate, and continued, by means of two cords passing through a bracket soldered to its lower radial corner, to two rings, G, placed around the thumb. If the extensors and flexors of the hand are intact, a joint may be placed in front of the articulation at the wrist, so that the hand may be extended and flexed by the action of those muscles. The action of this contrivance is to assist the paralyzed common extensor of the fingers and the extensors of the wrist.

Loss of Function of the Extensors of the Hand.—Paralysis of the extensor muscles of the hand is most commonly observed in painters, and those who use lead paints. It results from the poisonous influence of that metal when intromitted to the system. The paralysis is not confined exclusively to these muscles, but affects generally the common extensors of the fingers to a greater or less extent; the first row of phalanges cannot in consequence be raised to a level with the metacarpal bones, while, as a general thing, the second and third phalanges can be extended. It should also be further remarked that control over the flexor muscles of the hand may be to some extent impaired. The disease belongs to the class of bilateral or symmetrical affections, yet the corresponding muscles are not commonly affected in an equal degree, being more marked upon one side than upon the opposite. The extensors of the feet are occasionally affected in the same manner, so that the toes drop when the feet are raised in performing the act of locomotion, compelling the patient to step high, that the toes may not catch against the ground.

The paralysis is sometimes readily cured by appropriate medication, while a considerable number obstinately resist all treatment, and become permanent, the muscles undergoing atrophy and degeneration, conditions which render a cure, in the majority of cases, forever hopeless.

Fig. 189.



Apparatus for paralysis of the extensors of the hand.

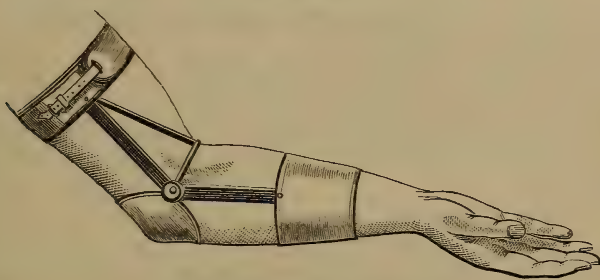
The mechanical treatment can scarcely do more than afford some alleviation to this distressing condition. In certain cases an apparatus consisting of a laced wristlet (Fig. 189) extending half way up the forearm, from the roots of the fingers, composed of slips of India-rubber, will confer some extent and firmness of the grasping power.

Loss of Function of the Biceps of the Arm.—Paralysis of the flexor muscles of the forearm, resulting from traumatic or other causes, inflicts upon a patient a serious drawback to the utility of the upper extremity in the pursuit of his avocation.

The functions of this muscle may be temporarily supplied by mechanical means, which will at the same time promote ultimate restoration of the limb by enabling the patient to exercise the injured muscle—a condition requisite to the re-establishment of its healthy tone.

The apparatus (Fig. 190) for this purpose is very simple, consisting of two padded straps to embrace respectively the arm and forearm, and connected together by two lateral metallic bars jointed at the elbow; a padded plate extends between the joints posteriorly to receive the olecranon, and to offer a solid resistance to the displacement of the elbow backwards when the arm is flexed. The motive power intended to supplement the action of the biceps muscle is obtained by using two elastic cords placed upon each side of the arm and extending between the anterior portions of the side levers and the middle point of the arm strap. These cords, by their elasticity, flex the arm after it has been extended by the voluntary efforts of the patient.

Fig. 190.



Apparatus for paralysis of the biceps.

Loss of Function of the Scapular Muscles.—The large and powerful muscles which contribute largely to retain the head of the humerus in the glenoid cavity—the deltoid, spinate, and scapular—may become so relaxed as to permit the bone to become dislocated upon the application of slight exciting causes, and when this condition is also associated with relaxation of the capsular ligament, as it usually is, to a greater or less degree, the bone slips from its socket spontaneously. The most obstinate cases of this kind originate from paralysis of the above-mentioned muscles after contusion of the shoulder, the humerus becoming spontaneously displaced, and the arm elongated and pendent. These muscles, in such examples, undergo atrophic degeneration; the deltoid, especially, has been observed to be reduced to almost a membranous condition, scarcely exhibiting any muscular fibres. In course of time the bones and cartilages entering into the structure of the joint also participate in the atrophy. These morbid changes frequently occupy many months in running their course.

Treatment.—The proper treatment consists in combating the inflammatory condition of the constituents of the joint by counter-irritants, as blisters, the actual cautery, and stimulating applications, particularly the oil of turpentine.

As it is desirable to maintain the functions of the limb intact, and yet secure the retention of the humerus in its socket, the best apparatus that can be employed is the following: With gutta-percha sheets, softened in hot water, make a mould of the upper half of the arm, as far as the acromion process, also one of the shoulder, and a small portion of the chest, connect them together by a narrow India-rubber ribbon at the point corresponding with the shoulder-joint. That part of the apparatus upon the chest can be secured by a circular lacing belt surrounding the body. By means of this arrangement the head of the humerus will be held in the glenoid cavity, while the arm is being exercised in its natural functions.

Some persons have endeavored to secure the retention of the humerus by preparing and applying a solid gutta-percha splint to both the upper half of the arm and shoulder.

Still a third plan has been employed with success. It requires a short crutch to be placed in the axilla, supported by a broad band passing from its lower extremity over the opposite shoulder. A second band encircles the chest and injured arm, so as to maintain the latter immovable.

SECTION IV.

APPARATUS FOR REMEDYING LOSS OF FUNCTION OF PARTS OF THE LOWER EXTREMITIES.

Some of the most difficult and trying cases, to the surgeon, of loss of function of the muscles and ligaments occur in the lower extremities, from paralysis, debility, gout, and rheumatism, particularly from the first-mentioned disease, which, as it commonly results from centric causes, or morbid changes in the nervous masses themselves, is always of serious import, demanding that the efforts of the physician should be first directed to the relief of these important structures, upon the integrity of which the exercise of the functions of the muscles depends. In those cases where the patient survives the first shock of paralytic disease, and the nervous tissues wholly or partially regain, as they sometimes do, their capacity for originating or conducting the stimulus of the will, after the lapse of a longer or shorter time, a great deal may be accomplished in furthering the resumption of the lost muscular motility, by having recourse to suitable mechanical contrivances, composed of levers and elastic cords, to support the weight of the patient's body, and to supplement the lost or impaired functions, until the muscles shall have regained sufficient power to execute their natural offices.

The difficulties in the mechanical treatment of these cases will be increased, in proportion to the extent of the parts involved, and the prognosis will depend upon the nature of the cause disabling the muscles; for instance, the paralysis of the tibialis anticus, or peronei

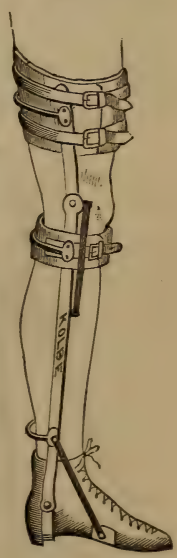
muscle, from local causes, is much more readily and quickly cured by suitable apparatus than the same disease originating from central causes, or changes in the encephalon or spinal marrow. Most frequently, it must be confessed, the larger proportion of cases fall into the latter category, and they vary much in their severity and extent. From some hitherto unexplained cause the extensor are more frequently affected by paralysis than the flexor muscles. The disease may involve the muscles generally, when the paralysis is said to be general, or may be confined to one limb or portion of the body—partial paralysis; when certain muscles or groups of muscles suffer, the paralysis is said to be local.

Loss of Function of the Tibialis Anticus. — Paralysis of the tibialis anticus is sometimes observed to be associated with central disease of the brain and spinal cord, but the most marked examples are those originating in impregnation of the animal economy with lead. Its characteristic features are inability to flex the foot upon the leg, which, in walking, drags along the ground, the toes striking against every obstacle. The affection is the analogue of "drop-wrist," and has been, not inappropriately, named "drop-foot."

In club-foot this muscle sometimes becomes so much elongated that after the operation of section of the tendo-Achillis, it does not contract, and maintain the foot in its normal relation with the leg, even after using appropriate apparatus.

Treatment.—The treatment of this disease consists in employing, along with the therapeutical remedies, iodide of potassium, cold douche, electricity, &c., a mechanical contrivance constructed in the following manner: Fasten a steel lever, jointed at the ankle upon the inner side of the leg, by attaching its lower extremity to the sole of a boot, and the upper extremity to a padded strap surrounding the leg below the tubercle of the tibia. Solder to the lever above the ankle-joint a curved metallic rod spanning the instep, and supporting at its extremity in front an aperture through which an elastic cord passes, connected below to the sole of the boot near the toe and above to the leg-strap. This cord serves the purpose of an artificial tibialis anticus, and lifts the toes when the patient is walking, so that they do not strike against the irregularities of the surface over which he passes, nor do they drag along the ground.

Fig. 191.



Apparatus for paralysis of the tibialis anticus.

In the annexed illustration (Fig. 191) is shown an apparatus which may be employed when, besides the paralysis of the tibialis anticus, there is also deficient power in the extensors of the leg. The upper elastic cord extends the leg while the lower one raises the toes during the time the patient is walking. The rest of the apparatus is similar to the one described above.

Loss of Function of the Peronei Muscles.—The peronei mus-

cles are sometimes involved, along with the tibialis anticus, in paralysis, and then, besides being unable to flex the foot, the patient cannot abduct it.

Treatment.—This morbid condition requires, therefore, another form of mechanism than the one previously described to meet the necessities of the case. It consists of a side-stem articulated below to the middle of a short lever fastened by its posterior extremity to a short upright springing up from the heel of the boot. An elastic cord connects the anterior point of the lever with the padded leg-strap above, and by its action, both flexes and abducts the foot.

Loss of Function of the Extensor Muscles of the Legs.—We have alluded, in the previous instances, to paralysis affecting isolated muscles or a group of muscles of the lower extremities, and the instruments required for their treatment. In other cases, and indeed the majority of those that will come under the care of the surgeon, the paralysis extends to most of the muscles of both lower extremities, constituting paraplegia; or it may be confined to one of them, and this conjoined with a similar condition of the corresponding upper extremity, is then called hemiplegia. Of course in all these cases pharmaceutic medication, friction, galvanism, cold douche are to be had recourse to; and, after acute symptoms, if there have been any present, have subsided, and the patient so far recovered as to be in a suitable condition for moving about his room, or indeed for going out into the open air, the surgeon should endeavor, by mechanical contrivances, to aid the faltering muscles, and support the weight of the body during the time the patient is exerting himself in walking. In this manner the debilitated or paralyzed muscles will be stimulated to contract and to resume, to a greater or less extent, their wonted vigor.

Treatment.—The ordinary frame (Fig. 192) had recourse to in such cases will answer quite well in sustaining the patient erect while he exercises his legs in walking. The frame consists of two short crutches supported upon and sliding in a padded wooden ring, connected at a convenient height with a square frame borne by four upright arms moving upon castors.

Fig. 192.

Supporting frame for paralysis of the lower extremities.

The patient supported in this mechanism can, when his legs are braced with the apparatus described below, propel it forwards by the mere act of stepping.

In paralysis of a single lower extremity the apparatus (Fig. 193) required to

restore the lost muscular functions will consist: 1st. Of an external lever extending from a well-padded thigh strap to near the middle of the sole of the boot, articulated at the knee and ankle-joints; 2d. An internal lever, jointed at the knee and ankle, supported above by the thigh-strap, and connected to the sole in the same manner as the first lever; the apparatus is rendered still more firm by a padded strap connecting the two levers together below the knee; 3d. Two elastic cords stretching between the sole and the leg-strap, to flex the foot; and two other cords attached below to a short lever projecting anteriorly from the knee articulation, and above to the thigh-strap; these extend the leg upon the thigh. To carry the whole limb forward three elastic cords are employed, fastened below to a steel arc spanning across the knee and above to the pelvic band. The two levers are curved forward at the ankle so that they may be attached to the centre of the sole of the boot, and thus facilitate the lifting of the toes when the patient steps forward. Where there is a constant disposition of the knee to yield in a forward direction by the weight of the body, I sometimes use another form of artificial support (Fig. 194), in which the elastic cords are discarded and the knee is locked by the metallic rods extending between the straps posteriorly, as seen in the figure.

Fig. 193.

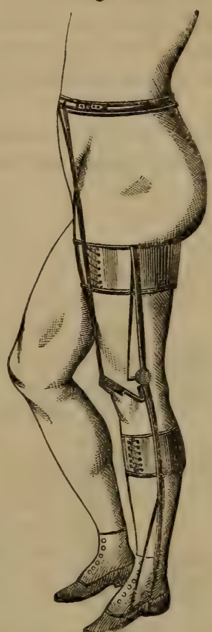
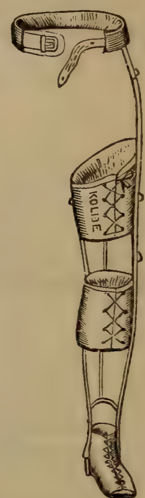


Fig. 194.



Apparatus for paralysis of one extremity.

These apparatus will be found efficient in those cases of paralysis where the two limbs are of the same length; in other instances the paralysis takes place during childhood, originating, perhaps, in the majority of cases, from perverted innervation depending upon some disease of the brain or spinal cord; the development of the limb is arrested, and the patient grows to adult age with more or less diminution in its length and volume. For such persons the foregoing instruments will have to be somewhat modified by the addition of a thick-soled boot to render the limbs uniform in length.

When the paralysis involves both lower extremities, a still more complicated mechanism (Fig. 195) will be demanded. It consists of two levers extending from the axillas to the soles of the boots, provided above with crutches, and articulated at the hips, knees, and ankles. These are secured to the body by means of thoracic and pelvic belts, thigh and leg-straps, and broad bands around the knees.

The India-rubber cords to imitate the action of the muscles are placed, as in the other instrument, at the hips, knees, and ankles. This apparatus may be occasionally modified with advantage by an arrangement which will enable the surgeon to lock the knee-joints by means of metallic rods connecting the straps upon the limb. (Fig. 196.)

In the beginning of the treatment of a case of paralysis of the lower extremities, the latter form of apparatus should be generally preferred, as the patient can get along better with it than when motion is permitted at the knee-joints; as it possesses more stability, he feels greater confidence, and will step out boldly, without fear of his knees yielding beneath him.

After the patient has gained some control over his limbs the rods may be removed and elastic cords substituted.

Fig. 195.

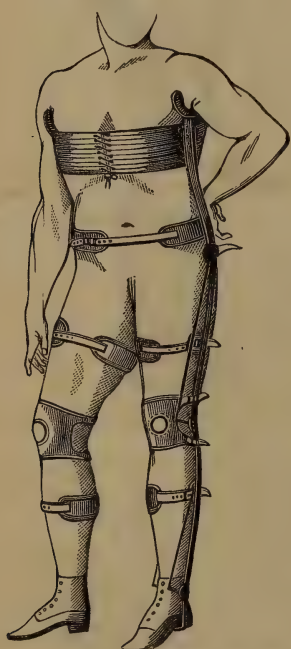
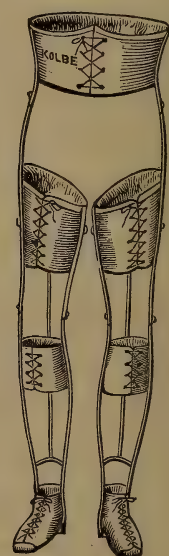


Fig. 196.



Apparatus for paralysis of both extremities.

Loss of Function of the Ligaments of the Knee-Joint (Knock-Knee, Genu-valgum).—This affection, next to rachitic curvature of the bones, is perhaps the most common deformity met with; it occurs at any period of life from infancy to adult age, and is rarely or never seen in vigorous manhood or old age. It is never congenital, and after infancy is, perhaps, most frequent between the ages of ten and eighteen years. Though the higher classes are not exempt from its attacks, yet it is found chiefly among the poor and ill-fed classes of society. This deformity is seen in Fig. 197.

The pathology of the disease has been shown to consist in a relaxed

condition of the internal lateral and posterior crucial ligaments of the knee-joint, so that the articulation gains other than antero-posterior motion, the only one it possesses in its normal condition. The leg, when flexed, has its ordinary position and relations; partially extended, the tibia rotates obliquely outwards, and in full extension, instead of being in a straight line it rotates laterally, leaving a space between the inner condyle and the head of the tibia. It is believed by some pathologists that the external condyle, being more pressed against than the internal, is arrested in its growth, when the disease has lasted from infancy, so that the inner condyle becomes disproportionally large and altered in figure, and causes the oblique outward rotation of the tibia observed to take place. Mr. Tamplin, on the other hand, does not believe that an actual enlargement takes place, but that it is only apparent in consequence of the gastrocnemius not following altogether the position of the condyle, but recedes from the tibia and femur on the internal side and passes in a more direct line to its origin. There is, however, an enlargement of the tubercle of the tibia sometimes observed.

Fig. 197.

Knock-knee.

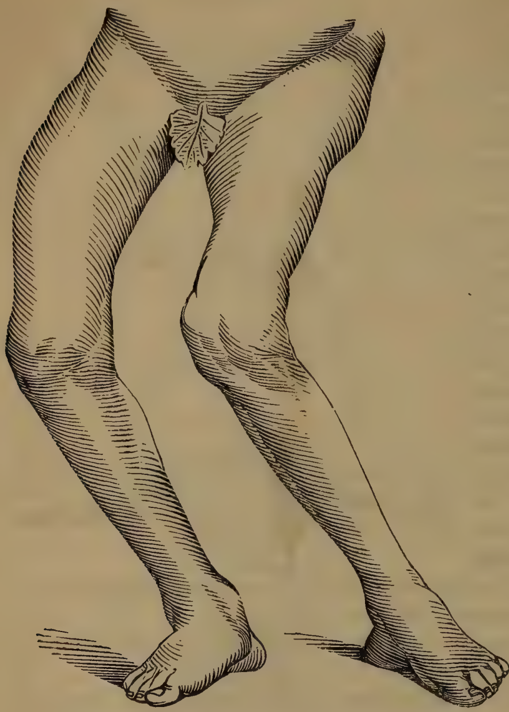
Knock-knee is often found associated with rachitic curvature of the femur and bones of the leg, and sometimes in infancy curvature of the leg bones occurs without this disease, but after ten years of age this result never occurs. In infancy, also, the malposition of the limb causes the astragalus to assume an oblique position, so that, with the yielding of the internal lateral ligaments of the ankle-joint, a spurious talipes valgus is produced; very rarely a true valgus, with paralysis of the tibialis anticus muscle, has been encountered.

One of the serious complications of knock-knee is curvature of the spine, resulting from obliquity of the pelvis in consequence of the unequal yielding of the two legs, which almost always happens in the course of the deformity; so that, to restore the equilibrium of the body, a curve must be formed in the spinal column with its convexity looking to the side with the longest leg. The disease is seen sometimes to affect but one knee; and again, in rare examples, the opposite knee curves outwards (Fig. 198); in these cases, for obvious reasons, spinal curvature progresses with greater rapidity.

It has been already stated that the predisposing cause to knock-knee is debility; the exciting causes are said to be the irritation of

teething, the eruptive fevers carrying heavy burdens, and standing erect too incessantly, as is required of youths in certain factories during their hours of labor. When the knees once begin to yield, the weight of the body, acting to a greater advantage upon the legs, causes the disease to progress with greater rapidity.

Fig. 198.



Knock-knee with outward curving of the opposite knee.

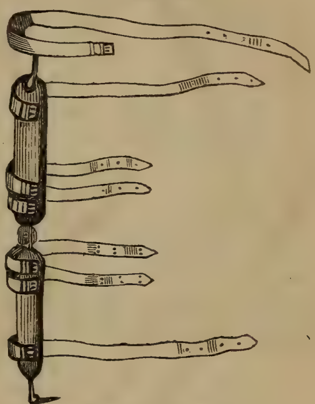
Treatment.—The treatment of knock knee mechanically is attended with great success, but it should always be associated with alteratives, tonics, nutritious food, and fresh air, to obtain speedy and lasting results.

In considering the mechanism of knock-knee with a view of obtaining correct mechanical principles upon which to construct our apparatus, we shall find that there has occurred a deviation in the shape of the limb, which normally represents a vertical column supporting the body upon its apex in the direction of the line of its axis, the extremities and fixed points of which are respectively at the acetabulum and ankle-joint. If now the internal lateral and posterior crucial ligaments yield, the knees will move inwards towards each other, and the body will then be supported in the direction of a broken line passing through the femur and tibia, and representing two sides of a triangle, the base of which is formed by the normal axis of the limb, and its apex by the knee-joint itself; the feet, receiving this weight in an oblique direction outwards, which the legs have now assumed, will be removed to a greater distance from each other, a condition which is always observed in this affection. An apparatus, then, to counteract it, should be a lever running parallel with the normal axis of the limb, and have two fixed points of resistance corresponding with the extremities of this axis, with straps or other contrivances acting from its centre upon the knee-joint from within outwards; in other words, from the apex of the triangle to its base.

The lever should not be jointed, at least in severe cases; as, when it possesses a centre of motion at the knee, every time the leg is bent the apparatus tends to rotate inwards at the hip, thus destroying the

force of the bands acting upon the knee; although in milder cases, or after the limb has been straightened by an inflexible stem, a jointed mechanism may be employed with advantage. Indeed, an instrument in general use is constructed upon this plan. It consists of a lateral splint, connected above to a padded pelvic strap, below to the soles of the boots, and jointed at the hip, knee, and ankle joints. Two straps are affixed to the stem, one to the thigh lever, which passes across the popliteal space and head of the tibia, to be buckled to the leg lever in front; another to the leg lever, which crosses the former in a reverse direction, to be attached to the stem above the knee. By this arrangement the straps support and act both upon the head of the tibia and the condyles of the femur.

Fig. 199.



Apparatus for knock-knee.

Another simple contrivance is shown in Fig. 199. It is composed of two concave splints connected together at the knee, one fitting the outside of the thigh, and the other the corresponding surface of the leg. The upper extremity of the thigh-piece bears a metallic stem, to which a pelvic strap is fastened; while the lower end of the leg portion is attached to the sole of the boot by a rectangular pin fitting into a socket. The requisite amount of lateral traction is obtained by the circular straps shown in the illustration, connected with splints and surrounding the limb.

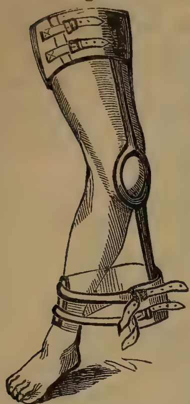
The straps in these forms of apparatus do not secure the limb to the lever with much firmness, and therefore much of their tractile power is lost when the legs are being used. To remedy this disadvantage to some extent, it is only necessary to substitute for the two knee-straps broad metallic thigh and leg-bands, well padded, and fastening to the limb with narrow leather straps and buckles. These bands, with a broad knee-cap, secure the limb firmly, and answer every requirement.

Another form of instrument may be employed in mild cases, and worn under the ordinary garments of the patient without being detected. The jointed side-stem is attached above and below to padded metallic thigh and leg-bands, while the knee is drawn outwards by a broad webbing knee-cap.

In the formation of knock-knee, the theory "that the lower part of the leg (tibia and tarsus) rotates from the inferior extremity of the femur, in an outward direction, and that the thigh always holds its original and perfect position," is held by some surgeons, and Mr. Hester, of London, based upon this view the construction of an apparatus (Fig. 200) which is thus described by Mr. Bigg: "It is constructed of two levers, with a large hollow-jointed disk at their point of junction, which receives the internal condyle within its circumference. Of these levers one corresponds with the proper line of the thigh, the

other with that of the leg, and both terminate by padded metal bands, those above the thigh, these below the calf. When the upper stem is fixed firmly to the thigh, a space is left between the inferior extremity of the lower stem and the internal malleolus of the tibia, proportional, of course, to the angularity of the limb; which space must be reduced by fastening the lower padded band as tightly as the patient can bear it." He also remarks that, "in the mechanical action of this instrument, the thigh-lever becomes a fixed point, its major fulcrum being situated at the inner condyle; while, as the resistance to be overcome is afforded by the lower leg, the calf-band presents the required means for reducing the space between the tibia and leg-stem. Kneeling can be performed at pleasure during the whole period of treatment, the knee-disk forming a ring-joint." In a severe case treated by me with this apparatus, it did not afford satisfactory results, and was abandoned; though in milder cases, I think, it would succeed.

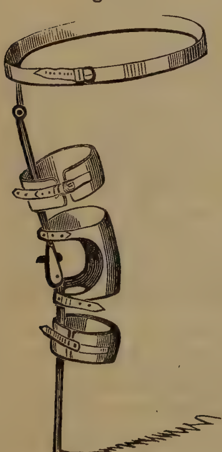
Fig. 200.



Hester's apparatus for knock-knee.

An excellent form of appliance (Fig. 201), in severe cases of knock-knee, is constructed with a lateral lever connected above to a padded pelvic belt, and below to the sole of the boot; the stem has joints at the hip and ankles, while, at the knee, there is a ratchet arrangement controlled by a key, by means of which it may be bent laterally to conform to the outer and concave sweep of the limb. To the stems are attached padded metallic thigh and leg-straps and a webbing knee-cap. By the gradual extension of the levers the knee is drawn outwards, and the extremity straightened.

Fig. 201.



Apparatus for knock-knee.

If there should be contraction of the knees along with the deformity, the addition of a second ratchet-screw to this instrument at the knee-joint, acting antero-posteriorly, will be required. Where the more elaborate apparatus cannot be obtained, an extemporaneous contrivance, described by Mr. Tamplin, may be used. "A splint made of two zinc plates, one portion to correspond with the thigh, the other with the leg; there is a straight piece of iron or wood attached by a hinge to the centre of each of the portions of the splint on the outside. The zinc, from being soft, admits of being applied close to the limb, and can be fixed by means of strapping in the position in which the joint is; a webbing-strap passed round the knee and over the connecting piece of iron, will, by gradually tightening it, effectually straighten the limb."

All forms and degrees of knock-knee may be successfully treated,

as far as mechanical means will accomplish it, by the apparatus now described. There are cases where section of the biceps cruris will be required to insure a satisfactory result before the apparatus is applied.

Loss of Function of the Ligaments of the Hip.—The capsular ligament of the hip-joint may become so relaxed in certain cases of children with feeble constitutions and relaxed habits of body, that the femur gains more motion than is compatible with steady and firm locomotion. The patient has a sensation of yielding at every step, as if he were walking upon some soft and yielding surface.

The mechanical expedient for correcting this unpleasant condition of things consists in making pressure upon the trochanter major from behind, forwards and inwards—that is, to press the head of the femur into the acetabulum. This may be accomplished by means of a metallic lever jointed at the hip, terminating above beneath the axilla in a crutch, and below in a short arm reaching to the middle of the thigh; this is connected to the body by a pelvic strap and a broad webbing-band surrounding the chest, while its lower end is secured to the thigh by a padded metallic strap. From beneath the joint a stem projects bearing a firm compress, regulated by a screw, to make the requisite degree of pressure over the trochanter. To prevent the apparatus slipping around the hips, an additional strap may be added, passing round the opposite thigh.

CHAPTER III.

APPARATUS FOR REMEDYING LOSS OF SYMMETRY OF PARTS.

SECTION I.

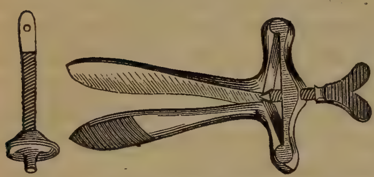
APPARATUS FOR REMEDYING LOSS OF SYMMETRY OF THE HEAD AND NECK.

Deformity of the Nose.—In fracture of the nasal bones, this organ may be bent over to one side or the other so as to produce a painful deformity, and indeed in the majority of cases of such injuries more or less distortion remains either because patients do not apply to the surgeon timely enough to have the fracture promptly reduced, or because, in consequence of the tumefaction of the parts the nature of the injury remains undiscovered until the opportune time has fled to correct the oversight or mistake. But even in instances where the nose has been bent aside for some time, continuous pressure will redress the organ to some extent. This may be accomplished by means of a firm pad borne upon the end of a metallic stem, moving by a ratchet arrangement, and sustained in position by being connected with a padded metallic spring surrounding the forehead. By the aid of a key the pressure may be increased or diminished at pleasure upon that side of the nose towards which the bend has occurred.

Immobility of the Lower Jaw.—Immobility of the lower jaw originates from preternatural contraction of the masseter and temporalis muscles, the formation of cicatricial tissue in the form of bands, or the establishment of osseous union between the jaws, and produces a painful and serious deformity in the configuration and symmetrical proportion of the features of the face. When of long duration the chin projects beyond the upper jaw, the lower incisors grow to an inordinate length, assuming a decidedly carnivorous appearance. The most frequent cause of this deformity is the destructive effects of the excessive use of mercurials upon the lower jaw and the soft tissues connected with it.

Treatment.—The mechanical treatment required in this disease consists in forcibly separating the jaws. For this purpose the instrument of Scultetus (Fig. 202), constructed upon the principle of the screw and lever, was commonly employed by the late Dr. Mott.

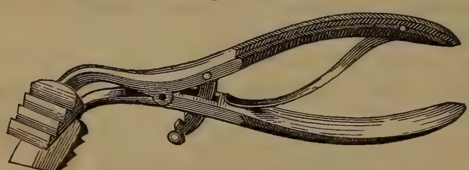
Fig. 202.



Scultetus' lever for separating the jaws.

Dr. Gross, of Philadelphia, regards the instrument exhibited in the annexed sketch (Fig. 203) as superior, as a mere lever, to that of Scultetus. It bears a close resemblance to the instrument used by Paré, and figured in his work.

Fig. 203.



Lever for separating the jaws.

Fig. 204.

Bigg's apparatus for separating the jaws.

For the same purpose Mr. Tamplin used an instrument fitting the teeth of the upper jaw, which acted as a fulcrum, and introduced over the teeth of the lower jaw small narrow blunt steel hooks attached to the instrument by means of a screw; with this he gradually forced the jaws asunder.

An ingenious modification of this instrument (Fig. 204), and one much superior to it, has been devised by Mr. Bigg; it is composed of "two firm but thin rods of metal accurately modelled to the chin and articulated at the point where the lower jaw has its axis of motion. To each rod is fixed a horizontal metal lip, which,

having been first covered with India-rubber, is inserted between the lips. By means of two vertical screws, fixed at the angles of the lips, the rods can be separated from each other and the mouth gradually opened."

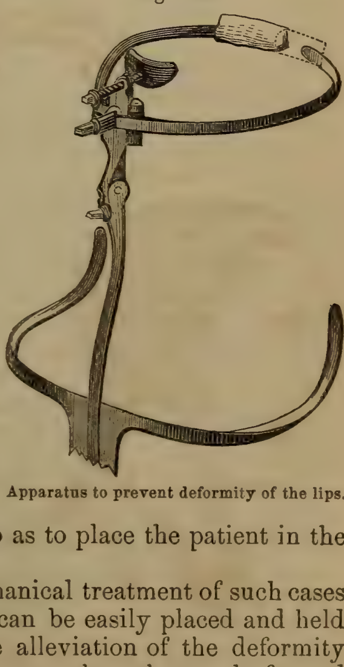
Projection of the Chin.—Sometimes, after the first dentition, but especially after the second, in certain children, the lower jaw projects beyond the upper so as to cause an unpleasant prominence of the chin.

Treatment.—The deformity may be corrected by bringing pressure to bear upon the chin by means of a sling bandage fastening over the occiput. An inclined plane made of gold or silver may be fastened to the lower teeth, sloping upwards towards the palate, which, when the jaws are brought together, forces the lower one backwards, and the upper one in the opposite direction.

Distortion of the Lips from Burns.—The surgeon can accomplish a good deal in preventing deformity of the lips, following burns, by placing those organs in favorable position during the contraction of the cicatricial tissue filling up the gaps left by the separation of the sloughs. The contraction, when unopposed, pulls the lips downwards, everts them, thus exposing the gums and teeth to view, and permitting the saliva to flow unobstructed from the mouth.

Treatment.—In carrying out the mechanical treatment, the indication is to make pressure upon the lips against the teeth and to raise the chin. This may be done by the following appliance (Fig. 205): A metallic stem projects from the apex of a vertebral lever provided with pelvic straps and axillary supports; the stem is jointed so as to move antero-posteriorly, and bears at its top two curved arms fitted with a movable pad at their extremities, which is intended to make pressure upon the lips, while the counter pressure is effected by a concave, padded disk, moved by a screw working through the stem above the point of attachment of the arms, acting against the occiput.

Fig. 205.



Apparatus to prevent deformity of the lips.

Deformity of the Chin and Neck from Burns.—Deformity resulting from burns of the chin and neck is often considerable, the contracting inodular tissue dragging down the chin and lips to the chest, destroying the symmetry and impeding the performance of the functions of the parts so as to place the patient in the most lamentable plight.

The most promising time for the mechanical treatment of such cases is during cicatrization, when the parts can be easily placed and held in any desirable position; though some alleviation of the deformity may be brought about at later periods, or when the newly-formed tissues have already contracted.

The most complete control can be obtained over the head by the use of an appliance (Fig. 206) composed of a vertebral lever, axillary supports, and pelvic straps, to which is added a cervical stem with two articulations, to obtain motion, antero-posteriorly and laterally. From the apex of this stem two arms project, moving vertically, by means of a joint, and capable of being opened or shut by simply turning a screw. The ends of the arms are furnished each with a short stem, padded at both of its extremities, and at right angles with it. These pads are intended to rest upon the temples and upper jaw, and to hold the head firmly in their grasp.

Fig. 206.

Apparatus for preventing deformity after burns.

Another form of instrument may be employed when the chin is mainly involved in the distortion. It consists of a cervical stem, fixed to a vertebral lever, as in the previous instrument, and having lateral and antero-posterior motion. To its apex are affixed curved, broad arms, grasping the occiput as far forward as the temples; the point of one arm supports a vertical lever terminating in a chin rest. With this instrument it can readily be understood how both the head and chin may be placed in any desired position.

Posterior Curvature of the Neck.—This deformity consists in the formation of a posterior curve in the lower cervical and upper dorsal vertebræ; sometimes the curve involves all the vertebræ to the last lumbar, constituting what has been called posterior curvature of the spine. Persons affected in the former manner present an appearance generally designated as *round* shoulder, or *stoop*.

Posterior curvature of the neck occurs in young persons between 10 and 16 years of age, and in both sexes. Its subjects are weakly, with health more or less impaired, soft flabby muscles, and growing rapidly. This condition of the system will be found to form the groundwork of the deformity, while its exciting causes are those employments requiring a person to stoop constantly, leaning over desks, &c.

The patient at first can readily correct the mal-posture of the neck when directed so to do, but by degrees, if the case is neglected, the curve becomes permanent in consequence of the anterior edges of the intervertebral cartilages becoming somewhat atrophied from pressure, and the muscles adapting themselves to the altered position.

This curve of the vertebræ necessarily causes the ribs to become more prominent, posteriorly raising the scapulæ, and in this manner giving the shoulders the rounded outline observed in these cases; at the same time the head and neck sink between the shoulders.

It is very important to make a careful diagnosis of this deformity from curvature produced by caries of the bodies of the vertebræ—angular curvature, as it is called. The main distinguishing points are, that in it, the obliteration of the curve occurs when the patient is placed in the horizontal position upon his face, and the spinous processes form an uninterrupted line, features never observed in angular curvature.

Treatment.—As the deformity is often associated with the strumous diathesis, the treatment will be directed to the removal of this constitutional vice, and the debilitated condition of the system. From what has been said concerning its pathology, the mechanism required to meet the indications of the case is readily conceived. A vertebral stem, with its upper extremity expanded and well padded to fit the shoulders, fastened to the body by shoulder-straps and a pelvic band. From the upper part of the dorsal plate a cervical stem projects, bearing at its upper end two curved levers, with broad and padded extremities to support the chin; these move, by means of a ratchet screw, vertically and laterally. When this instrument is applied the shoulders are drawn back, and the spine and head supported efficiently.

Angular Cervical Curvature.—A disease of a much more serious character than the one just now considered is angular curvature of the spine. It consists most often in a dyscrasic condition of the solids and fluids of the body with a deposition of the matter of scrofulosis or tuberculosis into the bony tissue of the bodies of the vertebræ with subsequent ulceration or caries of these parts. The most frequent seat of the disease is in the dorsal region, and eminently in the 2d, 3d, and 4th pieces, next in frequency in the lumbar region, and lastly in the cervical vertebræ. It is found to occur in all classes, though more frequently in the ill-fed, badly lodged denizens of alleys and lanes, and at all ages, yet more especially between 3 and 10 years, and in both sexes.

When the disease occurs in the cervical region, it is accompanied with an angular projection of spinous processes of one or more vertebræ, which distinguishes it from posterior cervical curvature.

Treatment.—In these cases, besides the constitutional and local treatment necessary, it is indispensable to support the head and neck by a suitable apparatus, lest in some unguarded movement, the diseased vertebræ cave in and crush the spinal cord.

Mr. Bishop, of London, has recommended a contrivance (Fig. 207) which will answer every purpose. It is simply a broad metallic plate, fitted to the spine, and well padded, having two arms affixed to its upper end, in which the occiput is intended to repose. The two pieces are connected by a joint which permits the head to move in every direction, except laterally, and in forced extension. The instrument is fastened to the person by shoulder-straps, thoracic and pelvic bands. In this manner the cervical vertebræ are securely held, and all motion of the head in perilous directions checked.

To answer the same purpose, a gutta-percha shield (Fig. 208), moulded to the back and posterior part of the neck, with an occipital

rest, may be prepared and attached to the body by a broad thoracic band and shoulder-straps.

These two forms of appliances are well adapted to children, who may be moved about securely, without fear of any sudden pressure upon the cord.

Fig. 207.

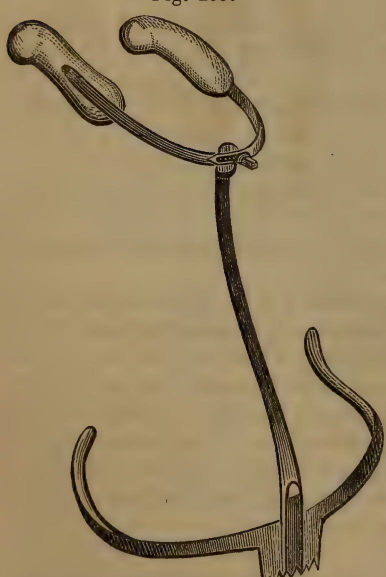
Bishop's apparatus for caries of the vertebræ.

Fig. 208.

Gutta-percha shield for caries of the vertebræ.

For the purpose of permitting a patient to stir about for the benefit of fresh air, without increasing the spine mischief, Mr. Bigg has designed an instrument (Fig. 209), composed of a vertebral lever and axillary rest, with a stem projecting from its upper end, bearing two padded arm-like processes, intended to grasp the head, from the occiput to the temporal regions, and hold it firmly; the arms can be elevated or depressed, and the space between them increased or diminished.

Fig. 209.



Bigg's apparatus for securing immovability of the head, in caries of the cervical vertebræ.

TORTICOLLIS, OR WRY-NECK. — This deformity consists in the permanent contraction of the cervical muscles, principally the sterno-cleido-mastoid, which draw the occiput towards the shoulder of the shortened muscle, while the face is turned in a corresponding degree in an opposite direction. The causes are, anything that destroys the balance of the muscular force upon the two sides of the neck, such as the stronger contraction of one of the sterno-cleido-mastoid muscles,

while the other retains its normal activity; or one muscle may become paralyzed, thus destroying the natural muscular antagonism. Rheumatic or other inflammation of the parts will produce the same result.

The disease is rarely congenital, and is observed most frequently between the third and tenth year of age.

Treatment.—Simple mechanical treatment will succeed, in mild cases, in restoring the head to its natural position; the severer ones will require the preliminary use of the knife to divide the tendon of the contracted muscle before the mechanical means are resorted to.

An apparatus sometimes employed is that of Prof. Jörg (Fig. 210), composed of a leather corset, and a fillet to encircle the head; these are connected by a small steel bar, moved by a ratchet arrangement under the control of a key.

Fig. 210.

Professor Jörg's apparatus for torticollis.

Fig. 211.

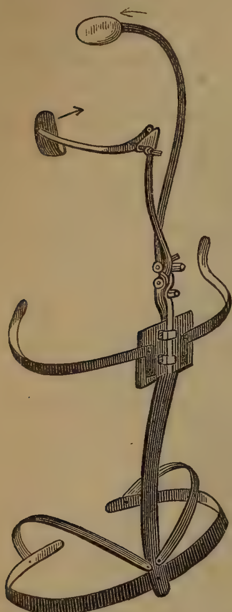
Bonnet's apparatus for torticollis.

Bonnet invented a much more ingenious and efficient apparatus, (Fig. 211) that does not embrace the chest and impede respiration. It consists of a plate of gutta-percha, modelled to the back and shoulders, to which it is fastened by straps passing beneath the axillas and around the waist. From the back part of this shield a metallic rod ascends, curving over the head, and capable of motion antero-posteriorly and laterally, by means of a ratchet-wheel. Through the top of the rod a screw works, supporting two padded arms, to grasp the sides of the head, and when in place they are secured by a strap passing beneath the chin.

By this arrangement the head may be held in any desired position.

An efficient contrivance was invented by Mr. Bigg, of London (Fig. 212), who describes it as "consisting of a padded pelvic band, to which is attached a vertebral stem with horizontal arm-pieces. At the upper extremity of the vertebral stem a neck-lever is fixed, to be attached or detached at will. This lever is formed in a peculiar fashion. It passes around the head, and rests, by its outer extremity, against the temporal bone, on the side towards which the head is deflected. On the opposite side of the head a horizontal lever is fixed, also springing from the vertebral stem, and resting against the lower jaw. The temporal lever has a vertical axis, moved by a ratchet-joint, upon turning which the head is gently pressed in a horizontal direction. The lower-jaw lever also acts horizontally, but in a different plane." He remarks: "That by the conjoint action of these two levers the contracted sterno-mastoideus muscle is extended, the head restored to an erect position, and the chin brought into the mesial line of the body. From the position of the lever, displacement of the head, when the instrument is properly applied, is impossible, and by a little modification of the dress and arrangement of the hair the mechanism may be almost entirely concealed."

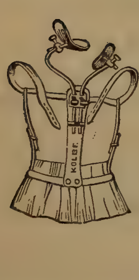
Fig. 212.



Bigg's apparatus for torticollis.

A greater range of motion of the arms, in which the head is grasped, is secured by the apparatus seen in Fig. 213, which, besides being enabled to change the position by the connec-

Fig. 213.



Apparatus for torticollis.

Fig. 214.

Same applied.

Fig. 215.

Apparatus for torticollis.

tion of their rods with the vertebral stem, also possess centres of motion at their apices; the extent of motion being regulated by thumb-screws.

The mode of applying the apparatus is shown in Fig. 214.

Of all the forms of apparatus for the treatment of torticollis, the one seen in Fig. 215 is preferred by me. It consists of a pelvic strap

and a vertebral stem, reaching to the occiput, and bearing padded metallic arms to grasp the head firmly; the arms are perforated upon both sides by oval openings, which leave the ears uncovered; to enable the arms to hold the head more securely, a chin and a frontal strap are fastened to them.

To give stability to the vertebral lever two axillary supports and shoulder-straps are attached to it.

The vertebral lever has, at its upper part, two centres of motion, one antero-posterior, and the other lateral, controlled by a key, which enable the surgeon to manage the movements of the head in the most perfect manner.

Where it is practicable, it is always desirable, in using wry-neck apparatus, that they take their *point d'appui* upon the hips, which confers upon them greater stability and power of holding the head firmly. If, from any cause, this arrangement cannot be pursued, Bonnet has suggested an apparatus to meet the emergency. It is constructed of a broad metallic plate, fitting the shoulders, and connected to them by straps passing under the axillas and across the breast. Upon each side of the collar a vertical bar is soldered, supporting at its apex a horizontal screw armed with a concave padded plate. One plate is intended to press against the lower jaw upon one side, and the other plate upon the cheek-bone on the opposite side.

With the same view Mr. Bigg suggests the use of a better instrument, consisting of a curved piece of steel resting upon the shoulder towards which the head is drawn, and retained in place by padded straps which pass under the shoulders. From the plate spring two levers with padded extremities. These levers are so arranged that one rests on the parietal region of the contracted side, and the other on the mastoid process of the opposite side, their action being governed and directed by ratchet screws.

SECTION II.

APPARATUS FOR REMEDYING LOSS OF SYMMETRY OF THE TRUNK.

LATERAL CURVATURE OF SPINE.—The deformity now under consideration is unconnected with ulcerative diseases of the vertebræ or caries, as is the case in angular curvature, except in extremely rare cases. The disease in the great majority of instances is observed among girls in the upper classes of society, between the ages of twelve and eighteen years.

Symptoms.—The disease often begins insidiously, making decided progress before the parents of the patient are fully aware of the seriousness of the condition of their daughter; perhaps, on inquiry, the physician will find some time to have elapsed since the first deviation in form was observed, appearing to be an "*outgrowing*" of the shoulder and corresponding breast. The patient's general health will sometimes remain undisturbed antecedent to the spinal deflection, though most often it will be found to have been more or less deranged. The appetite fails, the bowels become constipated, and the nutrition defective,

so that the patient loses flesh, is easily fatigued, and constantly seeks rest in a horizontal position.

In some instances, along with the feeling of great weariness, there will be more or less pain experienced in the back; sometimes the pain is continuous, and referred to the left side below the ribs.

In cases that have made some progress, the spinal column will be seen to have curved in the dorsal region to the right, and in the lumbar to the left; this is by far the most common condition, though the reverse may sometimes be observed in boys, and it then always depends upon the inordinate exercise of the muscles of one side or upon the maintenance of the body in awkward positions. The dorsal curve carries with it the ribs, and pushes those upon the right side backwards, forming a protuberance beneath the scapula, which then presents an unnatural prominence while the corresponding shoulder will be found elevated and projecting. The ribs connected with the concavity of the curve are flattened and the corresponding shoulder depressed. The formation of the lumbar curve causes a disproportionate prominence of the left hip, while the right one sinks in a corresponding degree. These changes are well shown in Fig. 216.

Fig. 216.

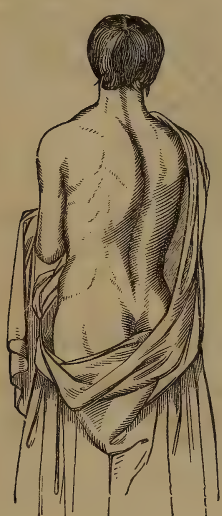


Fig. 217.

External appearances of lateral curvature.

If a third curve, formed by the upper dorsal and lower cervical, exists, as is sometimes seen (Fig. 217), the external characteristics of the disease now mentioned will be modified to some extent. The side of the chest upon the convexity of the dorsal curve becomes flattened, the corresponding side of the neck falls in, while the opposite side of the neck and chest appears much fuller, and is accompanied with an elevation of the shoulder; yet, though its scapula is higher, it does not project so much as the scapula upon the dorsal curvature.

In aggravated cases besides these mesial curvatures there is added another—helical curvature—formed by the bodies of the vertebræ rotating upon their own axes in the direction of the concavity of the curvature.

The shape and capacity of the chest are altered in consequence of the ribs becoming elongated, flattened, and twisted, thrusting the sternum and costal cartilages forwards, while they are unnaturally approximated to the pelvis. The spine is decreased in height, the muscles and ligaments upon its convexities stretched, and if the deformity results from excessive use of the limb upon one side they will be found more vigorous than their congeners, while those located in the concavities of curvature are preternaturally contracted, atrophied, and rigid. These changes in the bones of the spine and the ribs are seen in the annexed sketches.

Fig. 218.

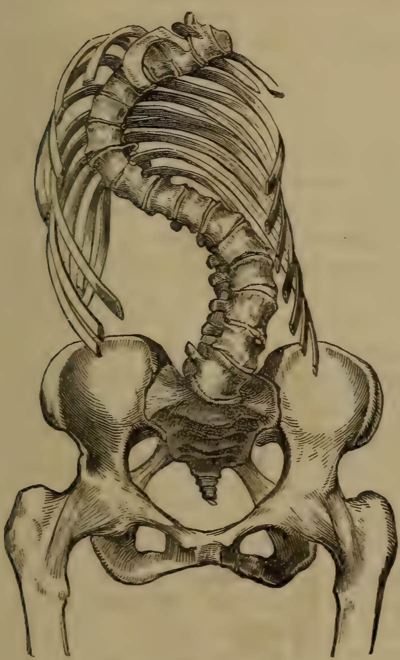
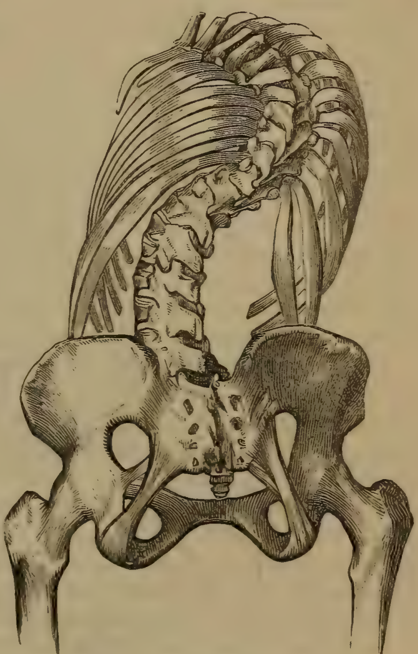


Fig. 219.



Appearances of the bones in lateral curvature of spine; front and back views.

The causes of lateral curvature are numerous, some of the principal are: Unequal muscular action, by which one set of muscles acts more vigorously upon the spine than those that counterbalance them, thus drawing it to one side; this is seen in blacksmiths, dragoons, and those persons who use one arm more than the other. The same result will follow if the equilibrium is destroyed by the muscles upon one side of the spine becoming debilitated or paralyzed from any cause, the stronger muscles will drag the spine towards their side. Anything that mars the uniform growth and development of the muscles will be likely to cause lateral curvature; we see this exemplified in

females who indulge in the pernicious habit of *tight lacing*, "the common effect of which practice is obstruction in the lungs, from their not having sufficient room to play, which, besides tainting the breath, cuts off numbers of young women in the very bloom of life. But nature has shown her resentment of this practice, by rendering above half the women of fashion deformed in some degree or other."

The fatigue of the spinal muscles produced by sitting with the back unsupported, for lengthy periods; habitually assuming awkward positions in standing, sitting, or lying will also induce it. Obliquity of the pelvis from inequality of the length of the lower extremities, the wooden pin, and other badly constructed artificial limbs are fruitful sources of spinal distortion.

Lastly, rickets will often be found to predispose to this deformity.

Treatment.—The successful treatment of lateral curvature requires on the part of the patient determination of will and a faithful adherence to the directions of the surgeon, inasmuch as the benefit to be obtained is not a question of days, but one of months. In the early stage of the disease, it may generally be overcome and a favorable issue brought about; later, when the deformity has become firmly established, the most that can be done is to ameliorate the patient's condition. Under the latter circumstances, the person should be promptly informed that two years of patient treatment, at least, will be required to obtain any decided and permanent improvement.

The first object should be to investigate carefully the cause of the deformity; perhaps the removal of this will arrest the progress of the spinal deflexion at once: for instance, inequality of length of the legs, from fractures, hip or knee disease, &c., must be corrected by the use of proper mechanical appliances, and the spine, by its own elasticity, will restore, in a short time, symmetry to the form.

Constitutional treatment is indispensable. Efforts should be made to establish the general health; to correct, as far as possible, the derangements of the stomach, bowels, and uterus so often observed in these cases; and to surround the patient by favorable hygienic conditions.

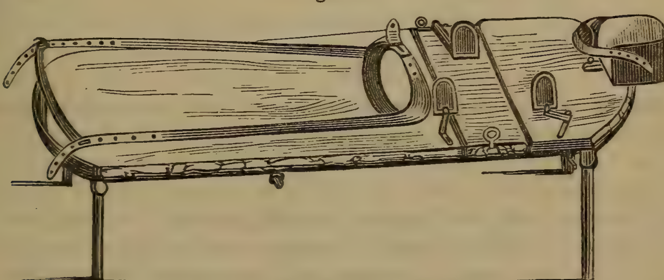
As to the mechanical treatment, surgeons have differed in opinion. Mr. Skey directs that the patient should be placed in the horizontal position to remove "the cause of the entire evil, viz., the superincumbent weight." He regards the horizontal position as quite compatible with health, with education, and with the enjoyment of life. His plan is to select a narrow bedstead about three feet in width, running on large wooden castors, by means of which it may be wheeled about in any direction. Upon this is placed a well-made wool mattress. When the patient is stretched upon this, he endeavors to unfold the spinal curves by making extension from the two extremities of the spinal column; that above by a belt applied around the chin and occiput, attached to a cord passing over a pulley let into the head-board of the bed, and supporting a weight of from ten to twenty pounds. That below is attached by a broad belt around the pelvis, and including the crista of each ilium. To the sides of this belt are two straps, that unite below, and to them may be attached a weight of from twenty to

thirty pounds. This extension may be worn sixteen hours out of the twenty-four of each day and night. To restore the projecting ribs to their natural form and relation, he employs a large pad covered with soft leather, arched to fit the projecting curve, and borne by a screw passing through an upright fastened to the bedstead; counter-pressure is established by two similar but smaller pads acting upon the opposite hip and back of the neck. The large pad should be made so as to press, not in the transverse or horizontal direction, but in that obliquely forwards; the smaller pads may press horizontally. This lateral pressure should be maintained as firmly as the patient can bear, for much of the success of the treatment depends on its efficacy and permanence.

To enlarge the capacity of the diminished half of the chest, he endeavors, by compressing the abdomen with a thick and soft pad of lint or cotton-wool, or a pad containing bran or horse-hair, and a broad bandage, to control the action of the diaphragm, and throw the duty of inspiration on the intercostal muscles, which are in a reduced and weakened condition. Mr. Skey remarks, in relation to this principle of treatment, that "it should be persisted in till observation of the back, to be occasionally made, obtain conclusive evidence of positive improvement. Nor, indeed, should it even then be desisted from, but rather modified as we approach, at the expiration of from eighteen months to two years, or possibly more, the period for entering on the second stage of the treatment—gymnastic exercises."

Similar to this couch, but gotten up with more elegance of mechanism, is a contrivance represented in Fig. 220, and employed by

Fig. 220.



Recumbent couch for lateral curvature.

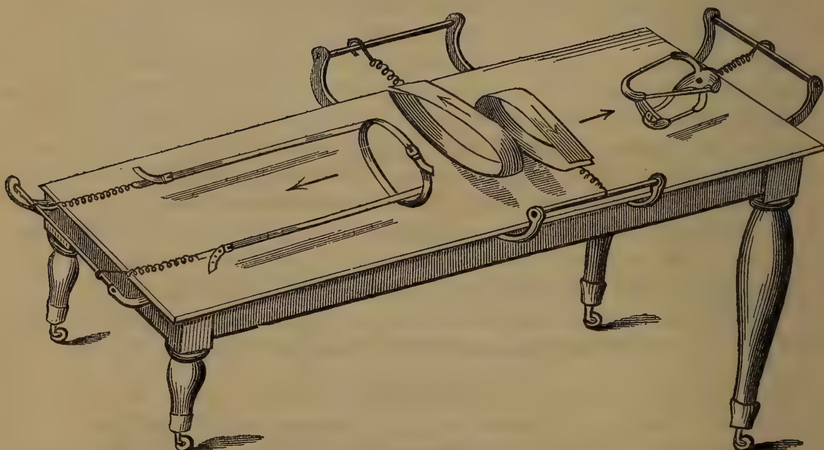
some of the German surgeons. It consists of three sections, the upper one corresponding to the cervical, the middle to the dorsal, and the third section to the lumbar curvature. To the upper end of the couch, a padded receptacle for the head is fixed, carrying a chin pad and strap. A padded band for the pelvis is connected by two lateral straps to a strong metallic spring secured to the foot of the couch. These are the mechanical provisions for permanent extension. To compress the dorsal curvatures, a broad pad is attached to the right edge of the plane; and two smaller ones to the left edge, to make counter-pressure upon the cervical and lumbar curves. By means of

a screw, the upper and middle sections are separated upon their left edge only, while a similar motion is impressed upon the middle and lower sections at the right edge.

The mechanical principle of the couch is evident: the arcs of the spine are extended from their extremities, while the pads exercise pressure upon their apices; the hinge movements of the sections act upon the column in opposite directions to its inflections.

An ingenious couch (Fig. 121), invented by Mr. Bigg, does not restrain the movements of the patient to the same extent as the two described above, and will be found useful in cases of moderate curvature, or in nervous persons as preliminary to the employment of more efficient couches requiring greater immobility of the body.

Fig. 221.



Bigg's couch for lateral curvature.

He describes it in the following manner: "The couch consists of a well-padded surface, having a rest for the head, which can be moved obliquely upwards by means of an elastic cord fixed to the upper rail of the plane."

"At the lower edge of the plane another rail is arranged for the attachment of two elastic bands belonging to a padded belt, which is fastened round the hips. Another rail is arranged at the side corresponding with the dorsal curve, and a fourth rail is fixed at the lateral edge of the plane answering to the lumbar curve. To both these rails soft webbing bands are fastened by elastic cords, and these webbing bands pass in antagonistic directions over the arcs of dorsal and lumbar deflections."

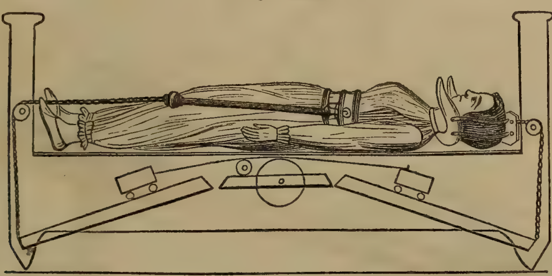
The apparatus contrived by Valerius, a mechanician of Paris, called the "corset-lit," is a very ingenious contrivance, and answers all the indications of treatment of lateral curvature as fully as any of the couches hitherto brought to the notice of the medical profession.

The mechanism consists of a padded model or mould of the posterior and lateral planes of the body divided into three sections, the first to embrace the back and chest, the second the loins, and the third sec-

tion to inclose the hips; these are susceptible of vertical and lateral movements by means of screw power, and may be placed at any angle that may be deemed, by the surgeon, the most expedient for the case under treatment. The head is secured in a padded support resembling somewhat the back part of a casque, and capable of being varied at any angle, while the body is rendered immovable by shoulder and pelvic straps. The frame itself is supported upon a board by means of straps.

Some persons have deemed it necessary to make extension only in the recumbent posture without lateral compression. This was the practice of Hippocrates, who established as points of extension the shoulders and hips of the patient. In France most of the couches are arranged with the upper extending cords acting upon the head. Of this sort is the one seen in Fig. 222, and employed by Dr. Maisonabe.

Fig. 222.



Maisonabe's couch for lateral curvature.

Mr. Tamplin, Erichsen, and others believe that, except in altogether exceptional cases, continuous treatment in the recumbent posture is pernicious, and, therefore, if patients can get around with any degree of comfort, it is the most judicious plan to employ some form of spinal supporter, permitting them to go out in the open air, and have recourse to some kind of gymnastic exercise in order to strengthen the serrati, rhomboidei, and the erector muscles of the spine.

These instruments are of two classes. 1st. Those that remove the weight of the head and upper extremities from the spine, and make lateral pressure upon it in opposite directions. 2d. Those that simply remove the weight without making the pressure.

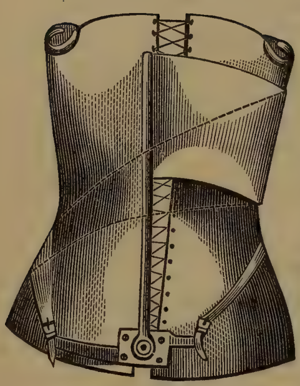
From what we have already stated concerning the mechanism of lateral curvature—that usually we find two curves formed, one in the dorsal region towards the right side, and the other or compensative curve in the loins looking to the left side, the vertebræ, as the disease advances, rotating always in the direction of the concavity of curvature—it can readily be gathered that those instruments must be most efficient that oppose these displacements, by the exercise of an antagonistic force, with appropriate levers and pads. Those belonging to the first class are most esteemed by surgeons in the treatment of lateral curvature; some of them exercise lateral force in opposite directions simply, while others have a rotatory action. In their construction provision is also

sometimes made to elevate the depressed shoulder, or to depress the elevated one.

The simplest form of a spine supporter, exercising lateral pressure, is a simple corset which transfers some of the weight of the upper extremities to the pelvis, but has at the same time the insuperable objection of compressing the chest, and impeding the development of muscular energy. Therefore it should be banished from use, particularly as there are other apparatus more efficient without these disadvantages involved in their construction.

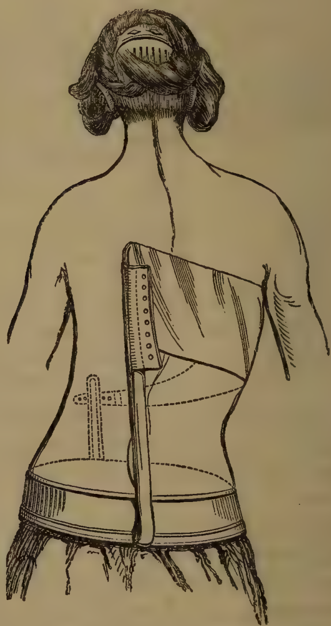
A modification of the corset is seen in Fig. 223. Two lateral crutch-form supports and a vertebral lever are connected with the corset, the latter bearing at its apex a broad webbing band which crosses over the dorsal convexity, then passes in front of the corset, and is finally attached by means of a buckle to an arm projecting from the base of the lever.

Fig. 223.



Apparatus for lateral curvature.

Fig. 224.



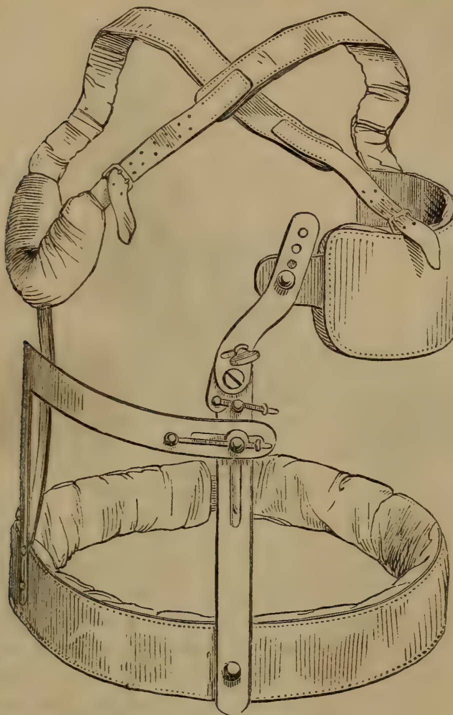
Tavernier's apparatus for lateral curvature.

Mr. Tamplin found Tavernier's lever-belt (Fig. 224) an excellent instrument in any slight case of curvature, which it promptly cured. Mr. Erichsen says that by this contrivance alone, properly and carefully adjusted to the condition of the deformity, many patients may be treated without the necessity of any confinement whatever. It consists, as seen in the wood-cut annexed, of a well-fitted pelvic belt, bearing a vertebral lever, having attached to its apex a triangular band of webbing, which is intended to pass over and compress the dorsal curvature, and to fasten by its apex to the point of a short stem

attached to the pelvic belt. To prevent the apparatus tilting or slipping up, a thigh-strap is sometimes attached, encircling the left hip.

In severe cases of curvature, Mr. Tamplin found another form of supporter preferable. It consists, as seen in the sketch (Fig. 225), of a

Fig. 225.



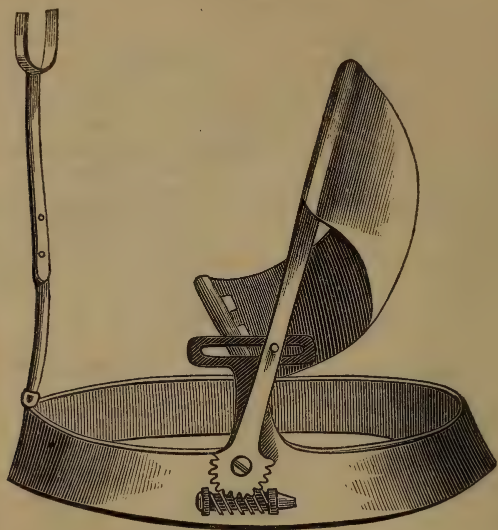
Tamplin's apparatus for lateral curvature.

band which encircles the pelvis, having a vertebral stem attached behind, at the upper portion of which is a movable pad, so made that it adapts itself to the projecting ribs, and with the screw the pressure can be regulated according to circumstances; beneath is an arm, which extends to the opposite side of the band, and which regulates the position of the vertebral stem, without causing the instrument to be displaced to any extent, by means of the screw presented in the diagram.

The apparatus of Mr. Lonsdale is similar to that of Tavernier; there is added a crutch support, which sustains the depressed shoulder and obviates the tilting of the pelvic belt. It will be seen that these forms of instruments act upon the dorsal curve only of the spine, leaving the lumbar curve unsupported, while the counter-pressure comes upon the left hip through the pelvic strap. To carry out fully the mechanical requirements demanded in lateral curvature, it should be the object of the surgeon to bring pressure upon the apices of the arcs of curvature, by two lateral arms projecting from

a vertebral lever, supported by a padded pelvic band, to expand the curves; and in those cases where rotation of the vertebræ has taken place, to bring pressure upon the ribs by two opposite parallel forces.

Fig. 226.

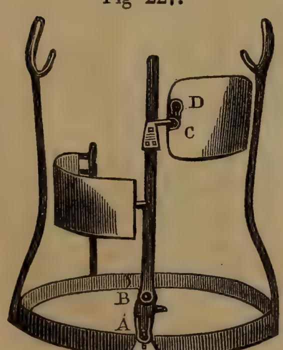


Lonsdale's apparatus for lateral curvature.

An instrument partially based upon this principle is much employed in this country. It consists of pelvic straps, to which a vertebral stem is attached, bearing at its sides two padded elastic plates to press upon the dorsal and lumbar curves in opposite directions; and at its top two horizontal arms projecting beneath the axillas, movable vertically and obliquely, by which the depressed shoulder may be elevated.

Mr. Bigg, of London, to secure these advantages, has invented the instrument shown in the annexed woodcut (Fig. 227), which has for its object pressure upon the curves in opposite directions, and rotative action upon the twisted vertebræ and ribs. He thus describes it: "It consists of a pelvic band sustaining two lateral uprights and a vertebral stem which carries a shoulder-plate. At the base of the back lever, where it joins the pelvic band, two centres of movement are placed, one (A) acting anteriorly, the other (B) in a lateral direction. Thus, on moving the former, pressure of the plate forwards against the shoulder is caused, and on moving the latter, lateral pressure against the ribs. The plate itself also has two centres of movement; one (C) corresponding with the horizontal rotation of the ribs on the spine, and the other (D) moving the plate in a vertical

Fig 227.

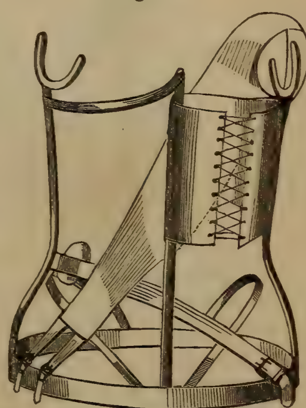


Bigg's apparatus for lateral curvature.

direction around its centre of attachment. By means of the horizontal shoulder movement (C) it was sought to act upon and re-rotate the ribs in an anterior direction. A controlling pressure was exercised upon the curvature by the movement (B) at the base of the vertebral lever. The shoulder itself was attempted to be depressed by the action of the vertical axis (D) in the shoulder-plate." As there was no counter pressure to the force exercised by the plate (D), little rotative action could have been expected, and it was to remedy this that he attached to the instrument subsequently, when the defect was observed, a padded plate, to rest against the antero-lateral surface of the thorax.

A very efficient supporter (Fig. 228), in cases of moderate lateral curvature, was much employed by Sir B. Brodie, and invented by a London mechanician; in it there is an arrangement provided for depressing the elevated shoulder. It is constructed with a pelvic band and hip-straps supporting two lateral crutch-like arms to support the shoulders, and a vertebral stem connected with the lateral crutch by a metallic rod at its apex. Upon the right shoulder there is a cap connected by a band to the pelvic belt, with a view to depress the former. Pressure is made upon the dorsal curve by a broad padded lacing-belt extending between the vertebral lever and the right crutch. The lumbar curve is acted upon by a pad and strap crossing the left hip obliquely.

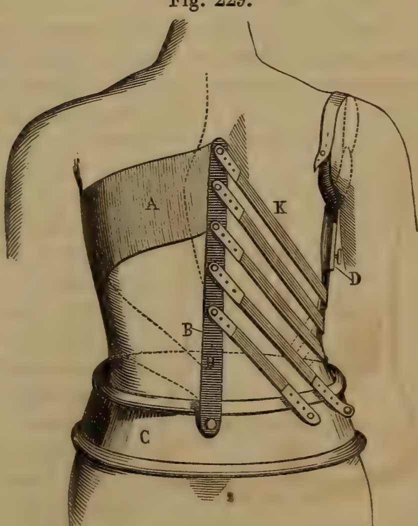
Fig. 228.



Apparatus for lateral curvature.

It has been proposed, and the principle has been carried out in a number of appliances for rectifying spinal curvature, to substitute the pressure of elastic cords for that of metallic plates moved by levers, ratchet-centres, and screws. This plan is adopted in the contrivances of Chelius, Joerge, and Duchenne. A sketch of the instrument of the latter is seen in the drawing (Fig. 229). It consists of a broad pelvic belt (C) supporting a vertebral lever (D) movable laterally at the point where the two parts connect. At the apex of the back stem a lever belt (A) is attached which passes over the dorsal curve to be

Fig. 229.



Duchenne's apparatus for lateral curvature.

fastened in front. By means of elastic straps (K) extending between the vertebral lever and pelvic belt the former is drawn over towards the side of the convexity of lumbar curvature, and the lever-strap thus pressed firmly against the dorsal curve. A crutch support passes also from the pelvic belt beneath the axilla of the lower shoulder.

A skilled mechanician of this city, Mr. Kolbe, has improved the apparatus of Duchenne somewhat by changing the attachment of the elastic straps from the pelvic belt to the lateral crutch (Fig. 230), so that they act to a better mechanical advantage; greater firmness is also conferred upon it by the introduction into the pelvic belt of two oval metallic supports bent to fit the hip at each side.

Fig. 230.

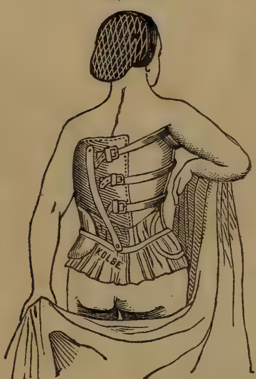
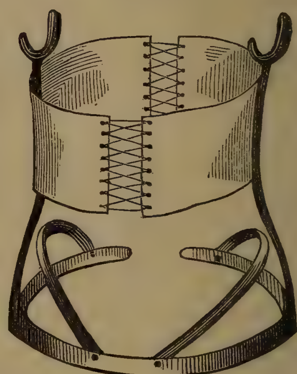


Fig. 231.



Apparatus for lateral curvature.

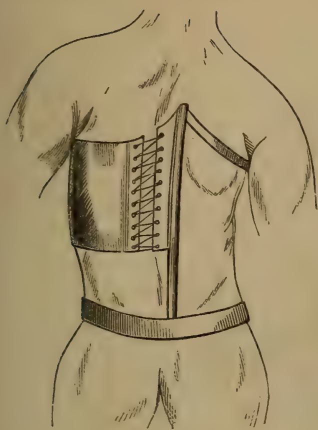
The second class of spinal supporters act by simply removing the weight of the head and upper extremities from the spine and transferring it to the hips. One of the simplest and oldest of these forms is seen in Fig. 231. It is prepared by fitting to the hips a well-padded belt, supporting two lateral crutches for supporting the shoulders, connected together by broad thoracic bands. This is an efficient contrivance, and will, perhaps, serve every purpose that any of the instruments of this class are capable of.

Bonnet and a good many of the French surgeons employ padded shields of the exact contour of the posterior surface of the body, fastening them by means of thoracic and abdominal straps. They are expensive, rather heavy, and more fatiguing to patients than the previously described apparatus.

In rare cases, as has already been stated, instead of the two or three curves usually seen in this deformity, the spine presents a single dorsal curve to either one side or the other. The shoulder and hip upon the side corresponding with the concavity are more or less approximated, while those upon the opposite side are separated in a corresponding degree and more prominent.

The mechanical apparatus required in single lateral curvature, when of moderate severity, may be constructed upon the principle of the apparatus already described, or the simple appliance sketched below (Fig. 232) will answer very well.

Fig. 232.



Apparatus for single curvature of the spine.

Fig. 233.

Appearance of posterior curvature.

POSTERIOR CURVATURE OF THE SPINE.—We have already considered posterior curvature as it affects the cervical vertebræ, and therefore it remains for us to describe this deformity as it occurs in the dorsal region. When the back is viewed from behind one continuous and uniform curve will be seen extending from the lower cervical to the last lumbar, as shown in Fig. 233.

This condition is most frequently met with in young children, and infants under twelve months of age. The patients presenting the deformity will be found suffering more or less from general debility and relaxation of the muscles and ligaments, so that the weight of the head and upper extremities causes the spinal column to sink and curve posteriorly. If the person is placed in a sitting posture, the trunk will incline forwards from sheer inability of the muscles to sustain the spine erect. Under the head of angular curvature of the neck the diagnostic differences of this deformity and posterior curvature have been pointed out, and they need not be repeated here.

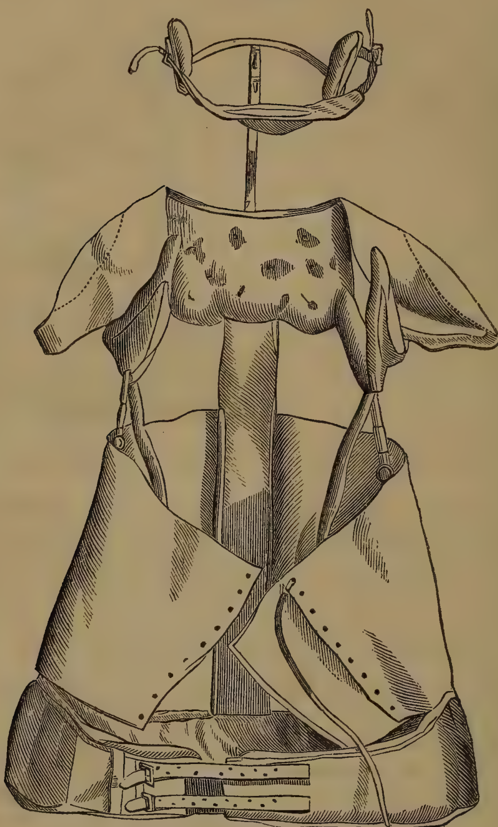
The medical treatment in this deformity should be directed to the restoration of the general health, the re-establishment of muscular tonicity, and the correction of any scrofulous or other constitutional taint by tonics, nourishing food (eggs, milk), &c. In infants the horizontal position will generally suffice to correct the deformity in a few weeks. In older persons, and in those cases where the disease has made greater progress, the persistent employment of mechanical means is indispensable.

One of the best forms of instrument for posterior curvature is seen in Fig. 237, at page 314; omitting the head-piece according to the cir-

cumstances of the case. The pads should be placed below the arc of curvature.

Mr. Tamplin recommends an apparatus (Fig. 234) somewhat similar, by which, at the same time that the weight is taken off the upper por-

Fig. 234.



Tamplin's apparatus for posterior curvature.

tions of the spinal column, a continued pressure can be kept upon the prominent portion of the curve by the back-board attached, and the shoulders held back by the straps. The head-piece can be removed at will.

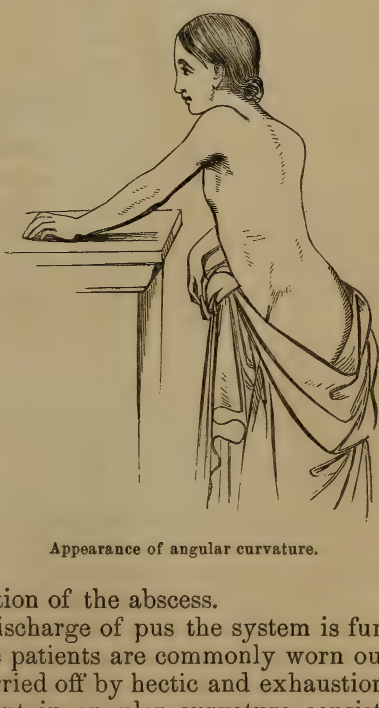
Angular Curvature (Fig. 235).—This deformity results from caries of the bodies of the vertebræ. It is most frequently met with in children, male and female alike, between the ages of three and twelve years, though it has been observed both earlier and later than these periods. Its more common subjects are those badly-clothed and fed persons living in dark and ill-ventilated hovels in the narrow streets and alleys of our large cities. The disease depends often upon a scrofulous or tuberculous diathesis, and is then attended with deposition of characteristic tuberculous matter in the osseous tissue and interverte-

bral cartilages of the bodies of the vertebræ. In other instances it proceeds from common inflammation of these parts, set up, in many cases, perhaps, by exterior violence inflicted upon the spine.

Symptoms.—During the formative stage of the disease the patient will display a general derangement of the health; pain in the back, at first slight, will generally be complained of, and, as the disease progresses, will become more severe. It is aggravated by any rude or unexpected movement of the body, as in making a false step or tripping. From the irritation of the spinal cord there will result more or less derangement of innervation of the parts below; the muscles of the legs will contract irregularly, or other perversions of sensation or motion will present themselves. The patient is disinclined to take exercise, from the sensation of weariness or weakness which he feels, and he habitually seeks repose in a horizontal position.

As the ulceration and destruction of the vertebral substance proceed, the above symptoms become more pronounced, and others of a more serious character are added. The extremities become cold and sluggish, and refuse to respond promptly to the stimulus of the will; the appetite entirely fails; the secretions are unhealthy; the respiration embarrassed; and the patient finally becomes emaciated, and loses control over the lower limbs, bladder, and rectum. It is during this time that the most characteristic feature of the disease is developed, namely, an angular curvature at some part of the spine, projecting posteriorly. It is formed by the spinous processes, and, as its name imports, is abrupt or pointed, a circumstance which affords the surgeon an important diagnostic mark to distinguish this disease from posterior curvature in which these processes form an uninterrupted curved line.

Fig. 235.



Appearance of angular curvature.

The destruction of the bodies of the vertebræ, upon which the angularity depends, is often accompanied with the formation of considerable purulent accumulations at the point where the diseased action is going on, and the matter generally makes its appearance externally either at the loins or groin, according to the position of the abscess.

By the continual formation and discharge of pus the system is further enfeebled, and in such cases the patients are commonly worn out by constant suffering, and finally carried off by hectic and exhaustion.

Treatment.—The medical treatment in angular curvature consists in the employment of tonics, alteratives, and stimulants—in fact, those

remedies appropriate to remove the constitutional taint of scrofula or tuberculosis; counter-irritation, by establishing an issue upon the side of the spine, with the actual cautery, will also be of immense service.

While the caries is progressing, all mechanical appliances should be abstained from, and the patient be placed in the horizontal posture; the prone being thought by some far more suitable for relieving pressure upon the spine and congestion of the parts than the supine. In regard to this point, Mr. Tamplin observes: "The plan I usually adopt is the following: to request that the parents should obtain a board somewhat wider and larger than the patient; let a horse-hair mattress be placed upon it, and let two circular holes be made in it at the point corresponding with the axilla, in which can be inserted a couple of plugs (one for each side), when the patient is in the inclined position, to prevent them from slipping down. With this simple contrivance, which is within the reach of all, from the facility of obtaining it, a child may be kept at rest, the disease protected from pressure, and the angle relieved, or, at all events, any increase of it effectually prevented; while, at the same time, it is the greatest possible source of comfort to the patients, who, instead of becoming fretful and irritable, with the health suffering as a consequence, as might be anticipated from the confinement, actually improve in health, and are most completely relieved from pain."

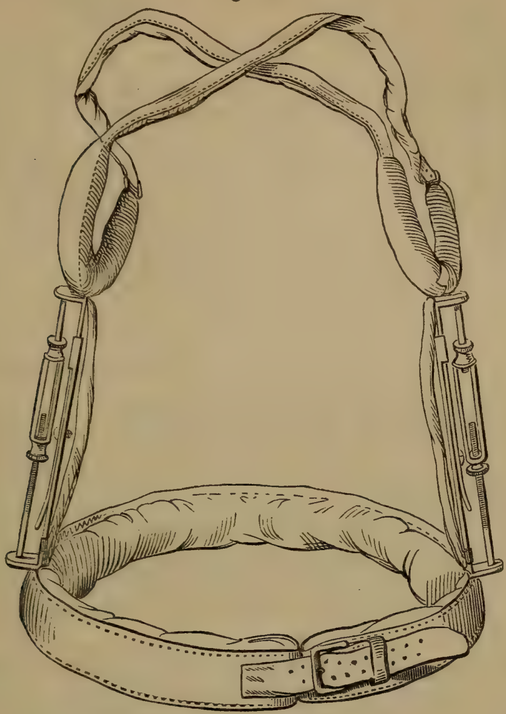
Mr. Erichsen prefers the couch of the late Mr. Verral, of London. In the construction of this couch of two inclined planes joined at an obtuse angle, he supposes that the twofold object of removing the weight of the upper part of the body from the spine, and slight extension of the spine by the weight of the pelvis and lower extremities upon the inclined plane, is obtained. On the other hand, Mr. Bishop takes a different view of the matter, for he employs the triple-inclined plane of Earle, and adopts a recumbent position, occasionally changing it from the back to the side. He says that the result of a number of observations is this—namely, that, in cases of curvatures of the spine arising from disease and absorption of the bone, the distortions do not increase while the body is kept in horizontal, supine, and lateral positions, but they do increase when the body is allowed to move and be erect; and that, moreover, when patients are confined to the prone position, so far as his experience goes, the curve of the spine is progressive, for which there are obvious mechanical reasons. For instance, in all cases, both of diseased bone and curvature, the superincumbent pressure cannot be wholly withdrawn in any oblique position; and where the curvature is in a plane or planes intermediate between the mesial and transverse, as generally happens, the deformity may often be increased by the tendency of the unsupported curved position towards the transverse plane.

When the patient has been kept in a horizontal position until anchylosis of the diseased vertebræ has taken place, which will require at least eighteen months, he may be permitted to go about with the spine carefully supported by a proper mechanical apparatus.

Mr. Tamplin employed for this purpose an instrument seen in Fig. 236, consisting of a band which encircles the pelvis, having attached

two crutches, one on each side, to support the shoulders, the crutches consisting of a male and female screw, which enables the surgeon to

Fig. 236.

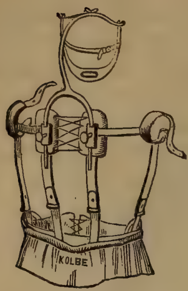


Tamplin's apparatus for angular curvature.

increase their length, provided relief is obtained, as the child grows. A broad flannel band should be passed round the crutch on one or other side, and over the projecting vertebra, then round the opposite crutch back again to the commencement of the band, and there united; by this means an effectual support is given without encircling the abdomen.

If there should be need of the spine being more firmly supported, and the weight of the head removed from it, it may be done with the instrument (Fig. 237) seen in the annexed woodcut, consisting of a pelvic strap supporting two lateral uprights reaching beneath the axillas; posteriorly two other uprights run up along the spine and bear at their apices two pads, which may be shifted up or down, according to the position of the angle upon the sides of which they repose; a soft belt extends between the pads and gives support to the apex of the angle. The vertebral rods support a bifurcated curved metallic stem which slides up and down upon them, and may be secured with thumb-screws; at its upper extremity it bears a chin sling and occipital strap, which hold the head securely. To give additional steadiness to the apparatus the pads are connected by two lateral straps to the crutches of the axillary supports.

Fig. 237.



Apparatus for angular curvature.

Fig. 238.

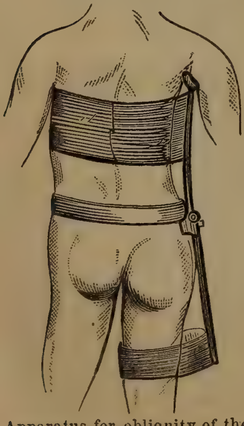
The same applied.

The apparatus is applied as seen in Fig. 238.

Loss of Symmetry of the Pelvis.—Obliquity of the pelvis is sometimes a result of anterior or lateral curvature of the lumbar vertebræ, or the cause may be in the pelvis itself; in the latter instance the obliquity will react upon the spine, and cause the formation of two or more curves in it, to restore the disturbed equilibrium of the body. One of the most common causes of this deformity is irregularity of length of the lower extremities produced by various agencies, as disease of the hip and knee-joints.

Young persons are the chief sufferers, and in some of these cases the carrying of heavy loads, the bad habit contracted by some children of supporting the weight of the body upon one leg while standing, or upon one hip while sitting, will be found the causative agents of numerous instances of pelvic obliquity presenting themselves to the notice of the surgeon.

Fig. 239.



Apparatus for obliquity of the pelvis.

This deviation is much more easily prevented than remedied. The cause of an incipient pelvic obliquity should be at once sought out and removed. For instance, if one leg is shorter than the other, by measuring with a tape line from the anterior superior spinous process of the ilium to the inner malleolus, the difference in length should be at once made up by a thick sole boot.

If the deformity has become firmly established an effort may be made by means of adhesive strips applied to the shortened leg and weighted to draw down the elevated hip; counter-extension can be made from the shoulders by passing a roller bandage under the armpits and fastening them to the head of the bed.

An ingenious contrivance used in this country for obliquity of the pelvis, as seen in Fig.

239, is composed of a lateral stem with a check-joint at the hip preventing its lower part raising perpendicularly. The upper part of this stem projects from the hip of the longest leg to the axilla, where it terminates in a crutch, and is secured to the chest by a broad webbing band; the lower part extends from the stop-joint to beyond the middle of the thigh to which it is attached by a padded plate; a pelvic strap gives additional security to the instrument. Its action in correcting the deformity consists in the drawing outward of the longer leg when a step is being taken, which must of course raise the hip and tilt the pelvis towards the short leg.

SECTION III.

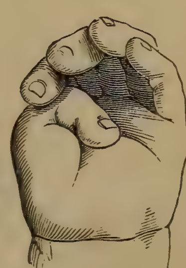
APPARATUS FOR REMEDYING LOSS OF SYMMETRY OF THE UPPER EXTREMITIES.

Deformity of the Fingers.—Contraction of the fingers is the deformity with which the surgeon has most often to deal in the upper extremities. It arises from various causes, and is either congenital or non-congenital. One finger may be affected only, or the whole of them at the same time.

The congenital cases are occasionally associated with deformities of other parts, as club-foot, and will be found to depend most alway upon a shortened condition of the skin upon the anterior aspect of the fingers, as shown in the annexed sketches (Figs. 240 and 241).

Fig. 240.

Fig. 241.



Congenital deformities of the fingers.

The most common cause, perhaps, of non-congenital contraction is thickening and diminution in the length of the palmar fascia. This condition is often seen to a limited extent in the hands of old sailors, and those engaged in laborious pursuits requiring the frequent use of the hand in grasping cylindrical objects, as ropes, and the handles of

the various kinds of tools used by artisans; the fascia sometimes even becomes nodulated. This condition is shown in Figs. 242 and 243.

Fig. 242.

Fig. 243.

Deformities of the fingers from contraction of the palmar fascia.

The late war has also furnished numerous cases of this deformity originating from gunshot and incised wounds of the forearm, hand, or fingers. Fig. 244 represents a case of the kind from a cut across the flexors of the forearm.

Fig. 244.

Deformity of the fingers from wound of the forearm.

Fig. 245.

Deformity of the fingers from contraction of the skin.

Rheumatic and gouty inflammation will produce similar results, and in some of these instances, besides the contraction of the fingers, irreparable injury is also inflicted upon the joints, rendering all hope of restoring their functions hopeless.

Contraction of the skin upon the anterior faces of the fingers will also produce and maintain the fingers in a permanently flexed position, as seen in Fig. 245.

Lastly, the destruction of the muscular equilibrium of the flexors and extensors by paralysis of the latter, will give rise to some of the most troublesome cases of contraction that the surgeon is called upon to remedy.

In the treatment of this deformity, if the flexor tendons are strongly contracted, tenotomy may be required before the application of mechanical apparatus; while, on the other hand, these appliances will suffice, in the majority of cases, alone in remedying contraction depending upon abnormal conditions of the skin, cellular tissue, and palmar fascia.

Mr. Tamplin frequently availed himself of the elastic force of a common watch-spring, bound to the dorsal aspect of the contracted finger; if more force was required than could be exercised by one spring, two or three of them were fastened together.

The instrument of M. Duchenne, already described, will answer occasionally.

In obstinate cases metallic stems, extending along the fingers, jointed at the digital articulations with ratchet-centres, and supported upon a metallic plate fitting the dorsum of the hand, will have to be employed.

Deformities of the Wrist.—The deformities encountered in the wrist are: 1. Permanent flexion from contraction of the flexors. 2. Permanent extension from contraction of the extensors. 3. Permanent abduction from contraction of the abductors. The first form is most common. The causes are rheumatic inflammation about the wrist-joint, and traumatic injuries and paralysis of the muscles of the forearm. The flexed position of the wrist (Fig. 246) admits of relief

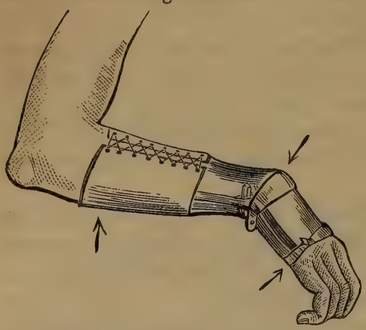
Fig. 246.

Contraction of the wrist.

by mechanical apparatus, which, by exercising a gradually extending force upon the parts, brings them into their normal position, when the joint may be exercised by means of elastic cords. A patient came under my care with contraction of the wrist and fingers from being violently pressed between two ships. The parts had been in this condition for seven months. I applied an apparatus seen in Fig. 247, to extend the joint. It consists of a padded forearm splint, to which is attached two lateral arms, extending to the basis of the index and little fingers, jointed opposite the wrist, and moved by a ratchet-centre and key. Extending between the two arms across the dorsum of the wrist is a padded plate; a strap encircles the metacarpus to sustain the ends of the arms. In this arrangement, by turning the key of the ratchet-wheel force is brought to bear upon the back of the wrist by

the padded plate, while the counter pressure is made upon the palm of the hand and forearm.

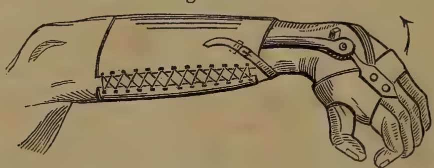
Fig. 247.



Apparatus for deformity of the wrist.

When the patient's hand was extended, the fingers were slipped into a sort of glove, inclosing only a narrow portion of the hand beyond their base. To this border a metallic strip was sewed, perforated with four holes; a wristlet was then applied, with a perforated metallic strip also attached to its lower margin; lastly, these two pieces of the apparatus were joined together by four elastic cords, provided with hooks. By persevering with the use of this mechanism, the functions of the hand were restored in four months. If the wrist is permanently extended, the same apparatus may be employed by simply altering the position of the dorsal plate, which must now be made to press against the fore-part of the wrist.

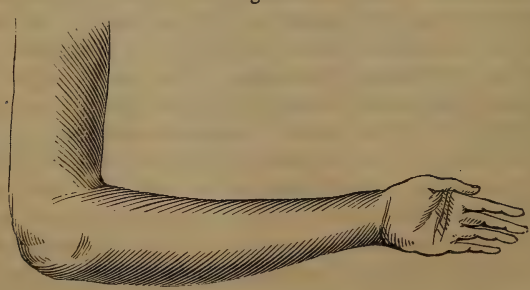
Fig. 248.



Apparatus for deformity of the wrist.

Permanent abduction, occurring from the contraction of the muscles upon the radial border of the forearm, may be overcome by the following mechanism (Fig. 248). Apply to the forearm a padded metallic splint, from the back part of which a short arm projects as far as a sheath fitted to the lower part of the hand, and to which it is fastened. Over the centre of the wrist this arm has a ratchet-centre, permitting lateral motion. To increase the adducting power still further, a lever-strap, attached by one extremity to the back part of the hand-sheath, passes around its ulnar border, to be fastened by the other to the posterior surface of the arm-splint.

Fig. 249.

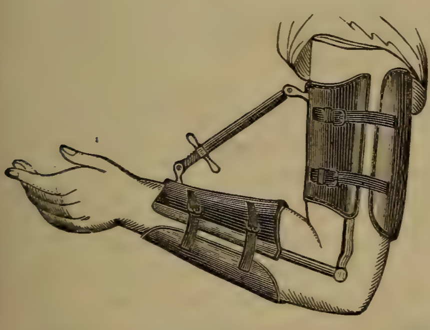


Contraction of the elbow.

Deformities of the Elbow.—The elbow may become permanently flexed (Fig. 249), or permanently extended from inflammation of the joint from any cause—rheumatism, contusions, fractures, and the like, where the arm is kept in a bent position for a long time. One case, coming under my observation, resulted from the wheel of a small gun-carriage passing over the arm below the shoulder; no fracture was produced nor even the skin broken.

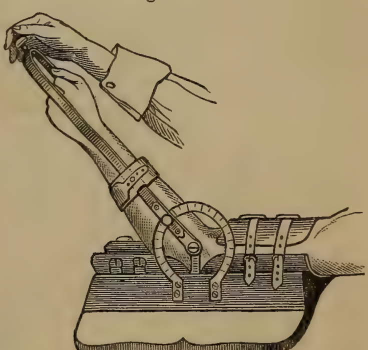
The mechanical treatment of these cases consists in gradually extending and flexing the arm, until the elbow is freely movable, and the muscles resume their functions. The contrivance of Stromeyer, modified by Mütter, as seen in Fig. 250, is commonly employed to make the extension; the force being obtained by an anterior screw connecting the upper and lower splints. This arrangement causes an unpleasant amount of pressure at the upper part of the arm and lower part of the forearm, while the elbow tends to project posteriorly. A better form of apparatus may be constructed in which the articulation of the lateral levers is moved by a key acting upon a ratchet-centre, while the elbow is prevented projecting posteriorly by a padded strap passing across it.

Fig. 250.



Stromeyer's apparatus for anchylosis of the elbow.

Fig. 251.



Bonnet's apparatus for the same.

Bonnet has constructed an instrument of great power to effect the same purpose (Fig. 251), and it is superior to that of Stromeyer. It consists of a padded splint fixed to a board, in which the arm reposes. In the centre of this board two vertical metallic pins are placed to which two lateral levers are articulated at a point corresponding with the centre of motion of the elbow and extending along the forearm to which they are connected by a padded belt. The joint of the lever is the centre of a graduated metallic arc fastened to the side of the board to indicate the extent of movement, and bearing a thumb-screw to arrest and hold the levers at any desired angle.

Deformities of the Shoulder.—Contractions of the shoulder-joint are of exceedingly rare occurrence, and always result from inflammation in the articulation itself, or the soft tissues surrounding it. Chelius recommends the application of blisters, or other irritating remedies, for the purpose of inducing absorption of the interstitial

deposit originating in rheumatic, or other inflammation of the soft parts about the joint; and the cautious use of an extending apparatus.

An appropriate instrument may be constructed in the following manner: Make an exact mould with gutta percha, of the shoulder; and attach to the upper and lower margins two short metallic pins, to the apices of which two levers are to be articulated with the axis of motion corresponding to that of the joint itself, by means of two ratchet-centres moved with a key. Attach the levers to the arm by means of a padded strap.

SECTION IV.

APPARATUS FOR REMEDYING LOSS OF SYMMETRY OF THE LOWER EXTREMITIES.

Deformities of the Toes. Contraction of the Toes.—This deformity, which may affect one toe separately, or all of them at the same time, depends upon rheumatic inflammation of the small joints, or mechanical agencies producing such amount of irritation as to cause permanent contraction of the flexor muscles inserted into the phalanges, and the consequent displacement of them downwards; the wearing of narrow, short, and high-heel boots, for instance, is perhaps the most common cause. Fig. 252 illustrates the effects of a short boot upon the great toe, which is instinctively drawn back by the patient to avoid the pain.

Fig. 252.

Contraction of the big toe.

Fig. 253.

The "hammer toe."

Fig. 253 is an example of permanent flexion of the second toe sometimes called "hammer toe," which forms a sharp angle upwards at the juncture of the proximal with the second phalanx. Fergusson says, that "it seems to occur most frequently in the originally well-formed foot, in which this toe is a little longer than the others; and though probably a short shoe is the chief cause of the displacement, I imagine that there is a natural tendency to it, from the slender shape of the part and the influence of the flexor and extensor muscles. The latter seem to draw the distal extremity of the first phalanx upwards and backwards, whilst the former apparently have most effect on the furthest end of the toe, and, by drawing it downwards, increase the displacement."

In many of these cases of deformities of the toes the contracted

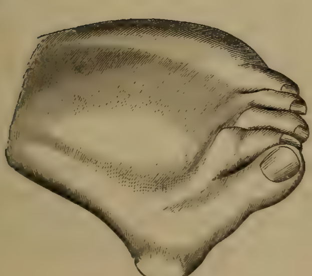
flexor tendons will have to be divided, after which a narrow splint must be placed beneath the toe to which it is fastened by a narrow strip of adhesive plaster.

Mr. Tamplin used, as an extension apparatus for the great toe, an iron plate made to fit the sole of the foot, having attached to its anterior extremity a raised spring, to correspond with the position of the toe; the splint is applied by means of strapping and bandage, with which any degree of pressure can be used. Success in restoring the joint to its extended position generally follows in the course of a couple of weeks.

I have seen one case where all the toes were in a position of forced extension, occurring in a perfectly healthy person. The deformity came on gradually, without any ascertainable cause, and required the tendons of the extensor to be cut, and the toes to be brought down by means of an apparatus composed of a metallic plate made to fit the sole of the foot, from the anterior part of which a curved stem projected, bearing a padded plate moved vertically by a screw, with which pressure was brought against the upper surface of the toes.

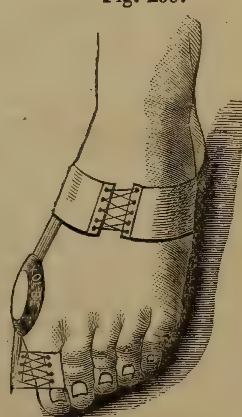
Bunion.—This deformity consists in the displacement of the head of the first metatarsal bone inwards, while the proximal phalanx is pressed outwards, thus making an angle at the first metatarso-phalangeal articulation, and separating to some extent the internal margins of its articular surface. It is always caused by wearing narrow-toed boots, or those having high heels, which throw a part of the weight of the body upon the ends of the toes. The deformity is seen in Fig. 254. A similar protuberance is sometimes formed over the fifth metatarso-phalangeal joint. The mechanical treatment of bunion is simply to discontinue the narrow-toed boot and substitute one with soft uppers and with a straight internal edge from the heel to the toe.

Fig. 254.



Appearance of bunion.

Fig. 255.



Apparatus for bunion.

An ingenious apparatus is sometimes employed to diminish this deformity. As seen in the figure (255), it consists of a short lever with a ring-joint at its centre, which reposes upon the bunion; the

stem is connected above to a laced bandage around the instep, and below it projects to the point of the toe, which is drawn out towards it by a little bandage.

DEFORMITIES OF THE FOOT AND ANKLE. CLUB-FOOT.—This deformity consists in the deviation of the foot in various directions from the normal form, and thus several varieties are met with, which are modifications, more or less, of four different types, viz: talipes varus, talipes equinus, talipes valgus, and talipes calcaneus, named in the order of their frequency.

In the first variety or talipes varus (Fig. 256) the foot is inverted, the outer malleolus is depressed, the heel raised from the ground, and the toes pointed inwards, compelling the patient to support the weight of his body upon the middle of its outer border. The dorsum of the foot is more convex and the sole more concave, while the constant irritation of the soft parts against which the pressure comes causes them to thicken, and a bursal sac to be formed in many cases, which answers the purpose of a soft cushion to ward off danger to the parts below. In slighter cases of this deformity the foot can be restored to its natural position by the hands of the surgeon, though it resumes its abnormal one immediately, and no changes in the soft tissues or bone have as yet taken place.

Fig. 256.

Talipes varus.

Varus is most always congenital, and has been observed in rare instances to be hereditary; in other cases it occurs subsequent to birth, and is caused by deranged innervation from teething, convulsions, neuralgia, paralysis, by keeping the foot in the same posture for any lengthy period, as may happen in fractures, wounds, or by anything which disturbs continuously the equilibrium of the muscles.

The changes that occur in the parts consist in elongation of the muscles upon the outer margins of the leg and foot and a corresponding contraction of those upon the inner sides; the bones of the tarsus, especially the os calcis, astragalus, scaphoid, and cuboid become more or less separated and rotated upon their axis without being dislocated from their natural cavities. If the deformities have existed for a long time, the bones then alter in shape, and become fixed in their unnatural positions.

Treatment.—After the operation, if tenotomy be required, the foot must be alternately flexed and extended to break up all morbid bands and adhesions, and an appropriate apparatus applied, which should be put on loosely the first few days, until the leg becomes accustomed to its presence, then tightened up gradually until the object is attained. The instrument must be worn night and day. It will add much to the comfort of the cure, and facilitate it, to some extent, if we sponge

the leg daily with the camphorated soap liniment, and use gentle friction for a few minutes.

As to the selection of a proper mechanical appliance, it should be remembered that the foot has undergone a threefold alteration in its position in relation to the leg, being in exaggerated extension, adduction, and rotation, so that the indications to be fulfilled in varus are flexion, abduction, and retroversion.

An apparatus that will answer in most of the congenital cases, and is easily obtainable, may be prepared by the surgeon in the following manner with adhesive strips, as recommended by Chelius: Take five or six strips of adhesive plaster, long enough from the foot to reach to just above the knee, and about an inch wide. Have the foot drawn into as natural a position as possible by an assistant, then apply the strips one after another, commencing upon the instep; make a turn about it, drawing the strips around its outer border, and then carry them up the leg; to render the whole secure, two or three circular pieces may be also put on. A splint is now to be placed upon the external side of the limb, projecting two inches beyond the sole of the foot, to which it must be bound by a figure of 8 bandage.

It has lately been the custom of some American surgeons to employ the elastic force of India-rubber in the treatment of club-foot. It exercises a constant, but yielding power in rectifying the distorted position of the foot; the rubber cords being put in such relation with the limb as to take the place and perform the functions of those muscles that have become abnormally elongated and weakened.

From the changes that always ensue, in the position of the tarsal bones, in the structure of ligaments and the muscles of the limb during a long-continued malposition of the foot, it requires patient and persevering employment of the treatment to secure a successful issue.

In congenital and a certain number of the postgenital cases the present plan will succeed without tenotomy, yet this operation is an invaluable resource in many instances, and the surgeon has, with present experience, little ground for hoping that it can be ever altogether laid aside for mechanical contrivances, as has been thought by some. With a clearer insight into the mechanism of club-foot the surgeon will be enabled to restrict tenotomy to those tendons only which offer an insurmountable resistance to the restoration of the foot to its normal posture; he can thus avoid that indiscriminate cutting of the various tissues about the ankle, often erroneously supposed to participate in the causation of the deformity, which has been practised in too many cases unnecessarily, with permanent injury to the patient.

Even in those cases apparently insurmountable, by the persevering use of *elastic traction,* success may be obtained, at least by assisting the action of the rubber-cords with force judiciously applied with the hands, while the patient is under the influence of an anæsthetic.

As the tractile cords are intended to supplement the impaired power of the muscles, they should be made to act as nearly as possible in the line of the muscles they represent.

To attain this object Mr. Barwell has suggested an ingenious plan of fastening them to the limb. In order to get an upper point of

attachment he secures to the leg an oblong piece of tin by taking a long strip of adhesive plaster, and applying half of its length to the tibia from the knee to just above the ankle; the strip of tin, which should be a little narrower than the adhesive plaster, is laid upon this, then the free end of the strip is carried up in front of the tin, with its adhesive side looking forwards; a roller bandage or circular strips of plaster should now be applied to the leg, and the terminal end of the strip brought down over the bandage so as to secure all. A wire loop is inserted into the upper end of the tin.

The lower point of attachment is established by applying across the bottom of the foot a trapezoid piece of adhesive plaster, with an eyelet in one of its corners; it is secured to the part by circular strips of the same material.

The rubber spring is stretched between these two points above and below by means of catgut cords. In talipes valgus the tin will be placed upon the anterior surface of the tibia, and but one elastic cord need be used, extending in the direction of the tibialis anticus, between the wire loop at the upper end of the tin plate and the eyelet in the plaster. In talipes varus the tin is secured just behind the fibula, and two traction cords are employed; the anterior one passing in front of the external malleolus, and representing the peroneus tertius, the posterior behind the malleolus, in the direction of the peroneus longus and brevis.

In cases in which the patient has walked, the weight of the body upon the margin of the foot approximates the external and internal arches of its sole; in other words, produces a longitudinal folding, which becomes gradually effaced by the same cause that produced it, namely, the weight of the body after the foot has been sufficiently abducted by the above described plan of treatment.

Dr. David Prince, of Illinois, has suggested a simple and efficient method of accomplishing the same object with the following contrivance: "For a patient ten years old take a sheet of gutta-percha one-third of an inch thick, or a sufficient number of thinner sheets to make that thickness, long enough to encircle the foot, and wide enough to extend from the middle joint of the phalanges to the medio-tarsal articulation, *i. e.*, the joint between the scaphoid and astragalus above, and the cuboid and calcaneum below.

"Apply upon both surfaces of the gutta-percha an investment of muslin of good strength, and lay the whole, thus prepared, into a pan of water nearly boiling hot. While the softening process is going on the foot should be wrapped with a roller, protecting the prominent points with pledgets of lint or cotton.

"As soon as the gutta-percha is thoroughly softened, it is taken out, still lying between its muslin investments, and so applied that its ends come together on the outside of the foot (in talipes varus), where the two extremes of gutta-percha should be welded by pressure between the thumb and fingers, previously dipped into cold water, to keep the material from sticking to the fingers.

"In talipes valgus, the extremities of the gutta-percha meet and project on the inner or median side of the foot. While the material is yet

warm and yielding, a square piece of pasteboard is laid upon the dorsal surface of the foot, with a corresponding piece of oiled-silk or rubber-cloth underlying it to prevent its softening by the moisture of the wet muslin investment, and a similar piece of pasteboard is applied directly opposite upon the plantar surface.

"A common pair of calipers, with screw fastening, is then applied, so that one leg rests upon the pasteboard upon the dorsal, and the other upon the pasteboard upon the plantar surface. The screw is then turned, to secure very firm squeezing between the opposing points. This compression is continued until the gutta-percha has become hard and unyielding, except by its elasticity. After this, the calipers are removed.

"A hole is then punched through the projecting gutta-percha, alongside of the metatarsal bone of the little toe in varus, and of the great toe in valgus. Into this hole a cord is inserted, which is fastened to a rubber ribbon or piece of rubber tube or cylinder, which must again have its attachments above by adhesive bands below the knee, above the knee, or by a padded roll to the pelvis, which is thereby encircled. This last is the least troublesome attachment, as it can at any time be slipped off and put on again. In the last method, a knee-cap is necessary to make the tension-cord follow the angle of the limb in walking and sitting. The appliance to the foot should be removed and reapplied every day in hot weather, and every alternate day in cold weather, to avoid excoriation from pressure and retained exhalations."

Dr. Alfred C. Post extols the gutta-percha shoe in the treatment of talipes. The material of which he constructs these shoes "is a gutta-percha sheet from a sixteenth to an eighth of an inch in thickness. It is cut of such a shape as to adapt itself to the sole and sides of the foot, leaving a space uncovered on the dorsum of the foot equal to about one-third of the breadth of the foot; it is also adapted to the sides of the leg, extending up two-thirds of the distance to the knee, and leaving a narrow space uncovered before and behind, each space so uncovered being about one-sixth of the circumference of the leg. The material is readily moulded to the shape of the limb by immersing it for a few seconds in water at a temperature of 100° Fahrenheit. He is in the habit of moulding the shoes, thus heated, over a wooden last made for the purpose. The last is not made after the fashion of a bootmaker's last, but it is shaped like the natural leg and foot, except that the outer side of the foot is made to correspond with the inner, thus obviating the necessity of having separate lasts for the right and left foot."

He generally commences the treatment of infantile club-foot by the subcutaneous division of the tendo-Achillis, after which he applies a strip of isinglass plaster over the small wound of the skin. He then has the foot held by an assistant as nearly as possible in its normal position, and while it is so held he carefully applies a roller bandage so as to cover the foot and leg, beginning the application on the outer side of the ankle. He then applies the gutta-percha shoe, an assistant grasping the leg with one hand, pressing the upper part of the shoe against the sides of the limb, and with the other hand pressing the

sole of the shoe against the sole of the foot. While the shoe is thus firmly pressed against the leg and foot, he applies a roller bandage firmly, so as to secure it in its place. After the lapse of twenty-four to forty-eight hours he takes off the bandages and shoe, washes the foot, wipes it dry, uses passive motion freely in different directions, and then reapplies the apparatus as before. The application is repeated at intervals of two or three days, until the foot is brought to its proper shape, when it is put up in a laced boot, lacing to the toes, and having a firm sole and stiff sides, provided with iron braces which extend nearly as high as the knee, and secured by a strap and buckle around the upper part of the leg.

Good sole-leather, pasteboard, tin, or some similar material, may be moulded to the limb in the same manner, forming serviceable and efficient splints.

Various other contrivances for the treatment of club-foot have been introduced to the notice of the profession, from time to time, by various surgeons and surgical instrument makers; all of them being modifications, of greater or less merit, of "Scarpa's shoe." The apparatus of this surgeon is rather complex, consisting of a thinly-padded metallic sole, to the posterior portion of which a semicircular piece of metal is attached, to embrace the heel above its point; a side-stem is connected with the heel-piece by ratchet centres in such a manner as to permit antero-posterior and lateral motions at points corresponding with the ankle; a curved spring also projects from the heel-piece along the inner side of the shoe, which is intended, by its pressure, to straighten the foot. The apparatus is connected to the limb by a metallic strap placed at the top of the side-stem, to encircle the leg below the knee, and by a number of leather straps and buckles.

Fig. 257.

Kolbe's club-foot apparatus.

A more simple and efficient apparatus is the one seen in Fig. 257, designed by Mr. Kolbe, of Philadelphia. It consists of two lateral metallic straps jointed at the knee and ankle, extending from the lower third of the thigh to a shoe of peculiar construction. They are movable upon each other, so that the instrument may be adapted to limbs of different lengths, and are connected to the leg by three padded metallic straps, one encircling the thigh, and the other two the leg. The shoe is composed of a lacing upper of soft leather, attached to a metallic sole divided into two sections, and movable laterally upon each other at a point corresponding with the medio-tarsal articulation, that is at the junction between the os calcis with the cuboid bone below, and the astragalus, with the scaphoid, above. The mechanism of motion

is simply a ratchet arrangement concealed in the sole of the shoe, and controlled by a key fitting to a screw-head placed upon its margin.

A short screw extends between the side-stem and the shoe, to move the latter antero-posteriorly upon a joint placed in the lateral stems at a level with the tibio-astragalal articulation.

When the instrument is applied the foot is firmly secured in the shoe by a broad strap encompassing the limb above the malleoli, and connected with the metallic sole by three smaller straps at its posterior and lateral sides.

There is no provision for lateral motion at the ankle, as in the contrivance of Scarpa; a complication of the apparatus that is entirely unnecessary, inasmuch as the foot can readily be abducted with the hand before it is encased in the shoe. The instrument is constructed with a view of first converting a talipes varus into a talipes equinus, and then bringing down the heel into its normal position.

Dr. Little, of London, has also invented a contrivance (Fig. 258) for varus. It is constructed with a padded metallic shoe, to which one side-

Fig. 258.

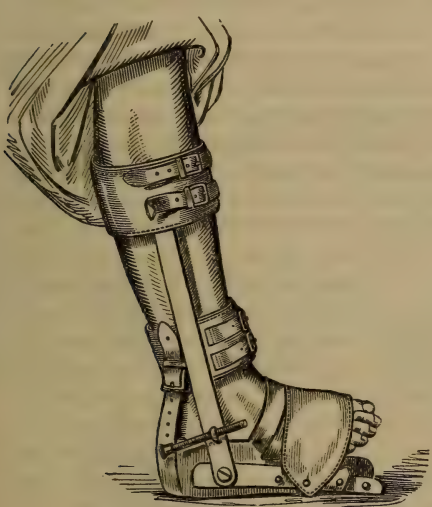
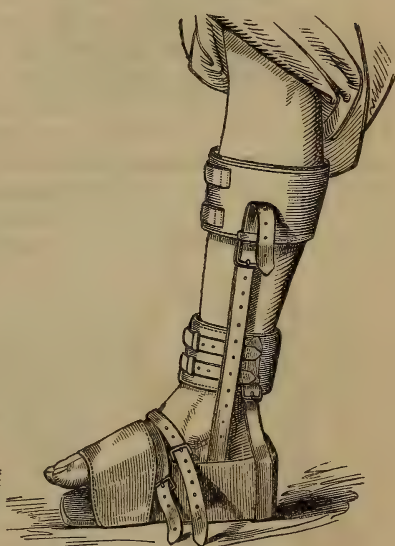


Fig. 259.

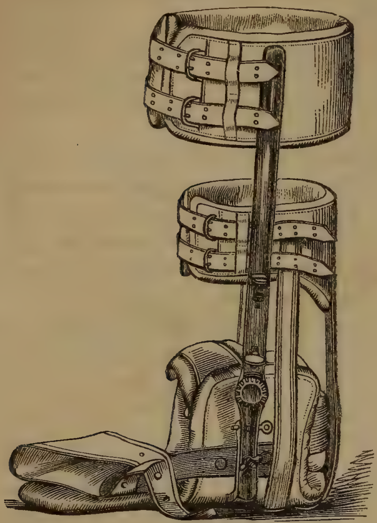


Dr. Little's club-foot apparatus. External and internal views.

stem for the perineal edge of the leg is movably articulated; the movement of flexion between them being controlled by a long screw extending between the stem and heel of the shoe. The foot is secured in the shoe by a broad belt passing over the metatarsus, and two straps crossing the instep. A padded strap connects the side lever to the leg below the knee, while another strap, placed above the malleoli, and connected by two straps to the shoe, prevents the heel rising vertically. The broad strap seen in the figure, running between the upper strap and shoe, is intended to check any sudden abduction

of the foot. When the screw is turned, the heel is gradually brought down, there being no further provision made to correct the adduction, while rotation is in some degree corrected by the ankle-straps.

Fig. 260.



Dr. Little's apparatus modified.

A modification of this instrument (Fig. 260), sometimes employed, has a horizontal lever reaching to the point of the big-toe from the heel of the shoe, and bearing a strap at its extremity to encircle the metacarpus, and by its pressure abducting the anterior part of the foot.

Talipes Equinus.—This deformity, seen in Figs. 261, 262, consists in a permanent contraction of the gastrocnemius and soleus mucles, raising the heel from the ground to a greater or less extent, and bringing the foot, the dorsum of which is unusually convex, with a corresponding concavity in the sole, nearly to a straight line with the leg, the weight of the body being borne upon the metatarsus and toes. In most cases, however, the foot inclines somewhat inwards or outwards; and when this occurs to any extent, it merges into the varieties called equino-varus and equino-valgus.

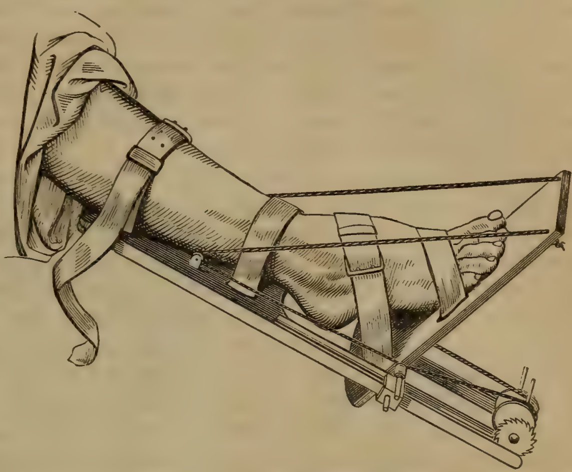
Fig. 261. Fig. 262.

Talipes equinus. External and internal views.

In children talipes equinus is caused by the irritation of teething, and

worms; in adults, by wounds of the leg, scrofulous disease of the joint, and rheumatism. According to Mr. Tamplin, it is rarely congenital. The principal displacement of the tarsus is a depression of the scaphoid and the projection of the head of the astragalus upon the top of the foot, while the tibia is displaced backward upon the facet of the astragalus.

Fig. 263.

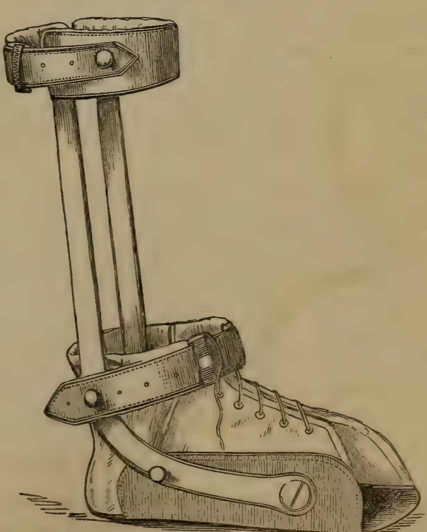


Stromeyer's apparatus for club-foot.

Treatment.—This form of club-foot is perhaps the easiest to treat mechanically, the indication being to draw down the heel after the division of the tendo-Achillis.

One of the earliest apparatus employed for this purpose was what is known as "Stromeyer's foot-board." It consists, as seen in Fig. 263, of a posterior splint which is fastened to the posterior surface of the leg by straps; to its lower part, a foot-board is attached by an axis, permitting vertical motion, and moved by cords winding around a windlass, situated at the bottom of the splint. The action of the instrument forces up the toes, and the heel descends in an equal ratio.

Fig. 264.



Liston's apparatus.

When applied to the foot the patient cannot move about, as is easily seen by the construction of the apparatus.

A modification of "Stromeyer's foot-board," by Liston, is seen in Fig. 264.

It is formed of a metallic shoe with a lacing upper, to the sides of which two leg-stems are movably attached, and connected above by a padded strap. A second strap crosses the instep to prevent the heel ascending vertically. The instrument acts by making a fulcrum over the astraga-

lus by the instep strap, and a point of resistance at the metatarso-phalangeal articulation; force now applied to the levers will necessarily cause the heel to descend.

The first instrument described for the treatment of varus is also arranged in such a manner that it may be used for equinus.

TALIPES VALGUS is the contrast of varus, and much less common than either of the two former varieties of these deformities. The foot is everted, the heel drawn up, the toes elevated, and the weight of the body is supported upon its inner margin; it has in fact become abducted, flexed, and rotated outwards.

The changes in the directions of the bones, in a case examined by Dr. Little, were: "The astragalus is twisted in such a manner that the articular facet, which ought to be applied against the inside of the internal malleolus, did not enter the composition of the ankle-joint, but was turned downwards; the navicular bone and calcaneum followed the astragalus, and, together with the internal malleolus, would have touched the ground with their internal surfaces, if the feet had belonged to subjects who could have walked. The external edge of the os cuboides, and fifth metatarsal bone, and external surface of the calcaneum presented directly upwards; the latter, therefore, was in contact with the external malleolus, the prominence of which could not be felt through the foot."

Valgus is generally produced by traumatic injuries, and is seldom congenital.

Treatment.—After the division of the tendons of the peroneus longus and brevis, and the extensor communis, if it be necessary, the proper mechanical apparatus for counteracting the deformity consists of a simple splint extending from the knee to the inner malleolus, from the lower extremity of this a spring projects along the inner border of the foot, having a soft pad attached to it to make pressure beneath the scaphoid; the end of the spring is bound to the forepart of the foot by a bandage or strip of adhesive plaster. With this apparatus gradually raise the arch of the foot, when an ordinary shoe with a pad fastened to the inside of it, at the inner margin of the sole, may be worn. The apparatus of Kolbe is also adapted to the treatment of valgus.

As the method of treating varus with elastic cords has already been fully explained, it is simply necessary to remark in this place that the same mode may also be adopted in valgus, the only modification required being that the cords must be made to act upon the inner margin of the foot instead of the outer, as in varus.

In simple yielding of the instep inwards, constituting splay-foot, a shoe with an India-rubber pad to rest beneath the scaphoid will be of great service. Some recommend that a curved metallic spring be introduced in the sole of the boot lengthwise the arch, but this is not so good as the pad.

TALIPES CALCANEUS.—This form of club-foot was so named, by Dr. Little, because the heel alone rested upon the ground (Fig. 265), while the rest of the foot stuck upwards, forming a more or less acute angle with the leg. This deformity is always congenital, and when seen

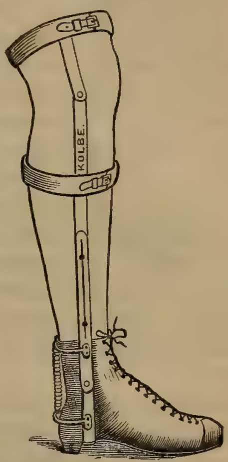
immediately after birth the foot may be easily restored to its natural position. It is accompanied with little or no displacement of the tarsal bones. A simple contrivance for correcting the deformity will be found in the application of a splint made of gutta-percha moulded to the back of the leg and sole of the foot while they are in a rectangular position.

A more complicated and expensive, but no less efficient apparatus for talipes calcaneus, is seen in Fig. 266, which is constructed

Fig. 265.

Appearance of talipes calcaneus.

Fig. 266.



Apparatus for talipes calcaneus.

with two metallic side-stems articulated at the knee and ankle, and connected to the limb with padded metal straps; they are connected below to the sole of a lacing shoe. Above and below the ankle-joint two metallic rods arch over the posterior margin of the leg between the side-stems, to which they are strongly riveted, and are connected on the posterior median line by a spiral spring, which constantly exerts an extending power upon the foot. The spiral spring may be replaced advantageously by an elastic cord.

Fig. 267.

Shoe to be worn in club-foot after the deformity has been rectified.

In all cases of club-foot after the deformity has been entirely overcome by appropriate apparatus, it will be well to exercise the foot for some time with an ordinary shoe (Fig. 267), with two lateral stems ascending to a point below the knee, and articulated at the ankle-joint.

Bowed or Bandied Legs.—In this deformity, seen in Fig. 268, the knees are widely separated from each other and the legs curved outwardly, which gives the patient an awkward waddling gait; there is more or less weakness of the limbs, and fatigue in using them, for the reason that the weight of the body is not supported in the line of their axis.

This condition does not depend, as knock-knee, upon a yielding of the ligaments of the knee-joint, but upon a curvature of the bones of the leg

Fig. 268.

Appearance of bowed legs.

itself—the tibia and fibula—which, in children of an unhealthy constitution and surrounded by bad hygienic influences, are often affected with rachitic softening, in consequence of the altered proportions of the calcareous and animal constituents of the bone. The legs, thus rendered unable to support the weight of the body, generally yield outwards, though sometimes forwards, or in both of these directions—forwards and outwards—at the same time.

In rare cases it affects but one leg, the other leg being curved inwards.

Treatment.—The general treatment with tonics and alteratives should be directed to the improvement of the constitution, while mechanical means should be employed to straighten the legs. This can be accomplished in eighteen months or two years, among children to whom the deformity is always confined. After the body has acquired its normal stature, and the bones acquired solidity, little can be accomplished in the way of cure.

A simple appliance, that will be found as efficient as any, is seen in the annexed drawing (Fig. 269). It is a well-padded splint extending from the condyle of the femur to below the malleolus, along the inner side of the leg, to which it is bound by two straps; three other straps pass around the splint and leg at the top of the curvature, intended to depress the arch formed by the curve of the tibia and fibula, while its abutments at the knee and ankle are sustained by the ends of the splint.

Fig. 269.

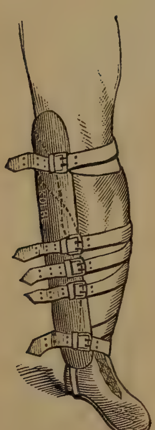
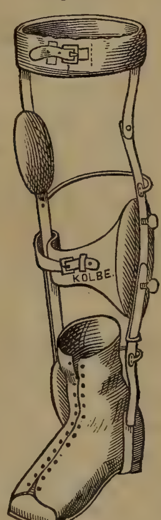


Fig. 270.

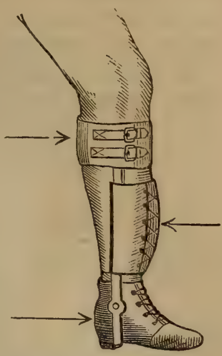


Apparatus for bowed legs.

Mr. Kolbe, of Philadelphia, has devised the apparatus seen in Fig. 270, for bowed leg. It is constructed of two metallic side-stems jointed at the knee and ankle, connected above to a padded metal plate inclosing the lower part of the thigh, and below to a laced boot. These stems are sufficiently flexible to be bent so that the instrument may be accommodated to the curvature of any limb, how great soever it may be. Upon the inner stem there are placed two pads, one above, to rest upon the head of the tibia, the other below, to occupy a position over the inner aspect of the ankle; these are intended as points of counter-pressure to the force exerted directly over the arc of curvature by the oval pad moving from the mid-

dle of the outer vertical stem by means of two screws.

Fig. 271.



Apparatus for anterior curvature of the leg.

In anterior curvature, alluded to above, an appropriate apparatus will be found in the contrivance seen in the annexed wood-cut (Fig. 271), consisting of two metallic stems jointed at the ankle, and connected below to the sole of a laced boot, and above to a metallic padded strap, which encircles the leg below the knee; between the side-stems two broad pieces of leather extend anteriorly across the convexity of the curved leg, and they are closed in front by a lacing cord running through their eyeleted margins.

Contraction of the Knee-Joint.—Contraction of the knee-joint, as the name implies, is the permanent bending of the leg upon the thigh at an angle. Its extent may vary from the slightest bend of the limb to the formation of a right or even an acute angle; and exists alone or may be accompanied with contraction of the flexors or adductors of the thigh, or with contraction of the muscles of the calf of the leg; in certain cases the tibia may be displaced a little laterally or posteriorly, even rotated upon the femur, all of which complications will be considered under separate headings below, with the apparatus appropriate to their treatment.

This deformity is caused by contraction of the hamstring muscles from paralysis, inflammation of the knee from rheumatism and injuries, by contraction and consolidation of the ligaments and fibrous tissues about the joints, nervous irritation, as in hysteria, and by osseous anchylosis.

Fig. 272.

Apparatus for contraction of the knee.

Two plans of treatment are pursued: in the first, the patient is laid upon his face, and the surgeon, seizing the foot of the distorted leg in his right hand, and steadying the thigh with his left, forcibly extends the limb. In the second, the limb is moved by gradual extension by means of apparatus either with or without tenotomy.

When the contraction is in the mesial line the instrument that will be found as efficient as any other is shown in the woodcut (Fig. 272), and was designed by Kolbe. It is constructed with padded metallic thigh and leg splints, connected by two lateral levers, articulations corresponding with the axis of motion of the knee-joint. When the force is applied by the screw connecting the splint posteriorly, the knee is prevented from springing forward by a padded ring placed over the patella and connected to the

upper and lower splints by four straps, and which form a fulcrum, or point of resistance, while the splints exercise pressure upon the anterior surface of the thigh and leg.

M. Bonnet used the apparatus seen in Fig. 273 for the purpose of restoring the functions of extension and flexion to the knee-joint. It

Fig. 273.

Bonnet's apparatus for contracted knee.

is composed of two lateral rods connected beneath the sole of the foot, and extending up the sides of the limb to the upper part of the thigh, and jointed at the knee; the rods are joined posteriorly by broad metallic troughs to support the leg and thigh, and to which they are attached by anterior splints, buckles and straps. To sustain the limb at the proper elevation while it is being exercised, two strong rods project from the thigh-piece to a triangular frame which supports them.

The motion is impressed upon the limb by a lever which is attached to the side-rods of the leg-piece beneath the knee; this is used to flex the leg; an extending cord runs from the arched portion of the instrument beneath the foot, over a pulley placed upon the supporting frame, and is held in the patient's hand; with this the leg is extended.

The manner of applying and using the apparatus is shown in Fig. 273.

Mr. Tamplin invented an appliance (Fig. 274) to meet the indications in that class of cases presenting lateral displacement along with flexion. It consists of leg and thigh splints connected together posteriorly by a stem, with an articulation admitting of antero-posterior and lateral movements; the power is applied by two screws, one upon the posterior and the other upon the lateral plane of the splints; the knee is prevented springing forward by a knee-cap. Its action is

similar to the one described above, with the difference that it has also lateral action.

After the knee has been straightened, it has been observed in some cases that the tibia is displaced backwards, the condyles of the femur and the patella remaining fixed anteriorly, as seen in Fig. 275. The

Fig. 274.

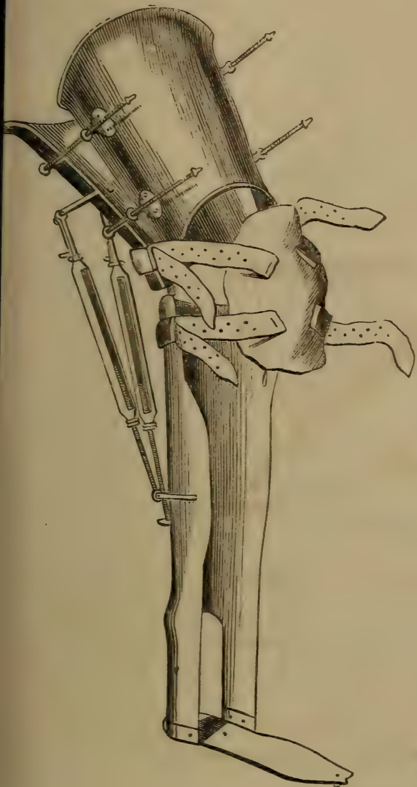
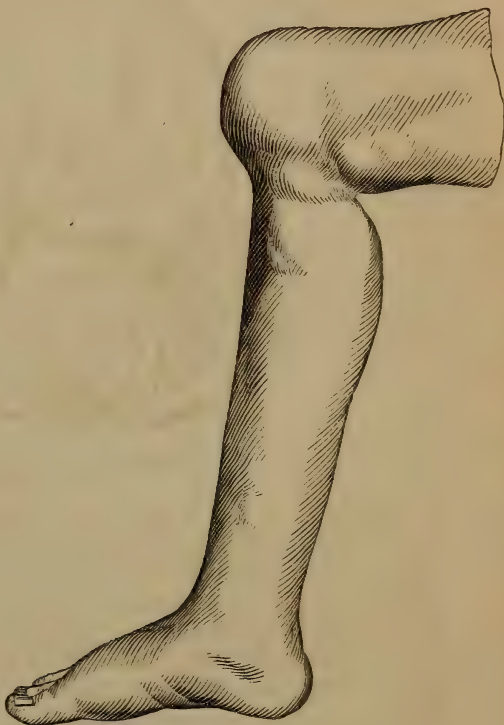


Fig. 275.



Tamplin's apparatus for contracted knee.

method of remedying this is to place the patient in a horizontal position, and make extension and counter-extension upon the leg until the head of the tibia is brought down, and then to apply an apparatus to retain it. For the latter purpose, Mr. Erichsen speaks flatteringly of an appliance designed and constructed by Mr. Bigg, of London. He thus describes it: "A and B are two levers, composed of metal, corresponding in their direction to the perpendicular position of the femur and tibia. C and D are two axes, placed exactly coincident with the centres of the articular ends of the bones. E and F are two powerful springs, whose action takes place in opposing directions, similar to the arrow indications in Fig. 276. This F presses the lever B in an anterior direction, bearing the end of the tibia forward; whilst E presses the lever A in a posterior direction, bearing the end of the femur

backward. As C and D are found acting above and below the actual axis of the knee-joint, they mutually influence the point formed by the apposition of the heads of the tibia and femur; and as it has already been explained that the femur really offers a fixed resistance,

Fig. 276.

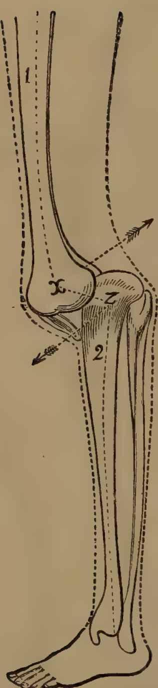
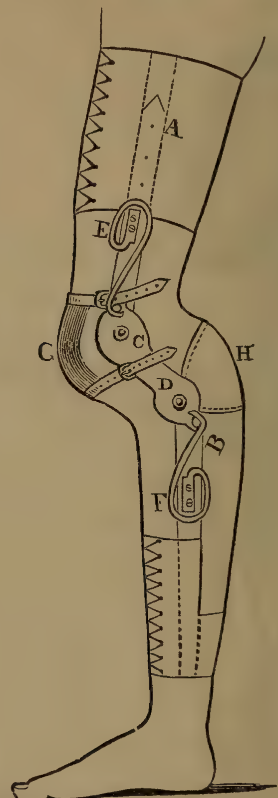


Fig. 277.



Bigg's apparatus for contraction of the knee.

and the tibia moves beneath it, the head of the latter bone is turned anteriorly in a semicircular direction, consequent on the upper centre (C) being a fixed point, and the lower centre (D) rotating around it. G is an elastic knee-cap; H, a padded plate. When the ligaments are tense, there is a chance of pressing the anterior surface of the tibia against the posterior surface of the femur. This is readily obviated by having the shaft (A) made to elongate, when the centre (C), being a little lowered, pushes the lever (B) downwards, carrying the tibia with it, and thus separating the osseous surfaces of the joint."

Contraction of the Hip-Joint.—Contraction of the hip consists in the thigh being bent upon the abdomen. In the greater number of cases there will be, besides flexion, more or less adduction of the thigh, by which the knee will be thrown towards or even across the opposite limb.

The causes of this condition are cerebral or spinal irritation, arthritic inflammation of the hip, violence inflicted upon the spine, and scrofulous disease of the hip-joint.

In those cases originating from irritation of the brain or spinal cord, other muscles will be affected along with the flexors and adductors of the thigh; there will generally be paralysis of the extensors of the leg and flexors of the foot, so that the muscles opposing them, being no longer counteracted, will by their action produce more or less contraction of the knee and foot; club-foot is also commonly associated with contraction originating from this source.

In those instances again which spring from some violence impressed upon the line of the spine, paralysis of certain muscles will be induced, while their unopposed antagonists will contract and maintain the thighs abnormally bent upon the pelvis; here, also, the legs participate to a greater or less extent in the contraction.

I have recently had under my care an adult in whom there was contraction of both thighs, originating from gouty inflammation of the coxo-femoral articulations. In cases of this description no paralysis will be found, as in the former instance; the limbs are maintained in that position in which, during the acute stage of the inflammation, they have been instinctively drawn by the patient for the purpose of alleviating the pain in the joints; the muscles insensibly contract and adapt themselves to the new condition of things.

But of all the above-enumerated cases of contraction of the hip, scrofulous disease of the joint, known under the name of *hip disease*, or morbus coxarius, is by far the most common. It begins almost always in the reticulated structure of the head of the femur, in young subjects between the ages of three and nine years. Cases have occurred inside of the first year, and as late as adult age, but they are rare. A case occurred in my practice, in which the patient was fifty-five years of age. While under treatment, which consisted in the application of a modified form of Davis's splint during the day, and the weight, cord, and pulley at night, the patient improved very greatly, so much so, indeed, as to induce him to quit the apparatus several weeks, during which time he took active exercise, and the consequence was that he was again brought to bed with acute symptoms of local inflammation of the hip-joint that ran on to suppuration, under which he ultimately sank.

This disease, like other scrofulous affections, is slow and insidious in its approach, being scarcely marked in the early period of its course by sufficiently distinctive characteristics to be recognized, except by the medical attendant.

In the *first stage* the child complains of weakness and weariness in the limb; he trips, in pursuing his accustomed amusements, with unusual frequency, and complains of pain in the knee corresponding with the diseased hip, although the knee does not present any evidence of disease.

In a variable period, from a few weeks to as many months, pain is felt in the hip from the sensitive nerves of the bone having be-

come involved, the limb, perhaps, loses a little flesh, but the patient's general health remains unimpaired.

In the *second stage* the pain in the hip becomes more decided; the health of the patient begins to fail, his digestive functions suffer, his sleep is disturbed, and there is some febrile excitement established. Along with the general wasting of flesh, the limb becomes attenuated and the gluteal region flattened; the gluteo-femoral fold, so marked upon the healthy side, is, upon the diseased one, completely effaced.

The limb is apparently elongated from the tilting of the pelvis toward that side; the loins present a hollow, while the abdomen is unusually prominent; the upper portion of the thigh becomes swollen and tender.

In the *third stage* the local destruction has made constant progress; the head of the femur and portions of the rim of the acetabulum are more or less removed by ulcerative action; pus has formed about the parts, and, after burrowing in every direction, finally escapes exteriorly, generally in the gluteal region over the joint. The pain is severe, and is greatly aggravated by impressing movements upon the limb, which is now really shorter than the healthy one in consequence of the ravages in the head of the femur and cotyloid cavity. The hip, instead of being flattened, as in the beginning, is now prominent, and the thigh is more or less bent upon the pelvis, and generally somewhat adducted.

The severity of the constitutional symptoms keeps pace with that of the local changes, the patient suffering from severe febrile excitement and copious sweats.

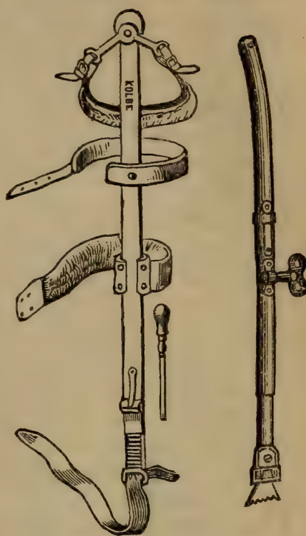
In rare instances the femur becomes dislocated upon the dorsum of the ilium, or even forwards upon the pubis, or upon the thyroid foramen, or backwards into the ischiatic notch.

In studying the phenomena of hip disease it is learned that it is of an essentially scrofulous character. The ulcerative changes in the hip-joint are progressive, destroying successively the head and neck of the femur, the cotyloid cavity, the cartilages, synovial membrane and ligaments. Irritation is set up and sustained by these changes so that the muscles are excited to energetic contractions, thereby adding still more to the rapidity of the ulcerative destruction by pressing the joint-surfaces forcibly together.

Therefore, in fulfilling the indications of treatment in hip disease, it will be necessary, first, to attend to the correction of constitutional impairment from scrofulous infection, and secondly, to separate the diseased bony surfaces by appropriate mechanical contrivances. The latter point, which alone concerns us here, will be considered. The necessity of making extension for the purpose of overcoming the energy of the irritated muscles, and separating the diseased joint-surfaces has been long recognized, and the principle carried out in various ways, usually by means of different forms of couches, to which extending bands were attached. This mode of treatment had the great disadvantage of keeping the patient in a recumbent position, and depriving him of the benefits of pure air, change of scene, and all those beneficial influences flowing from out-door exercise.

To Dr. Henry G. Davis, of New York, is due the credit of having first systematized the use of practical apparatus which admitted of effectual extension being made without confining the patient to recumbency.

Fig. 278 Fig. 279.



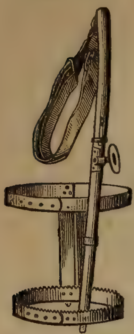
Dr. Davis's splints for coxalgia.

The apparatus of Dr. Davis, as seen in Fig. 278, consists of a long metallic side-splint, reaching from the hip to the ankle, consisting of two sections, which are movable upon each other by means of a key. "To the upper end of the splint a peroneal band is attached, formed of two bands of a length, width, and strength varying according to the size of the apparatus, and the circumstances of its application. One band is longer than the other, and inelastic, being made entirely of strong cotton or linen webbing; the other is, as it were, an oblong bag of India-rubber webbing (formed of sewing two strips of rubber webbing together), filled with sawdust, tipped at each end with some of the inelastic webbing. While the inside elastic band keeps up the extension required, the inelastic sustains any weight that exceeds the extending force as then applied to the patient. It is this arrangement that enables the weight of the body to be borne without harm, as in walking, and that prevents injury from excessive weight or pressure upon the articulating surfaces in cases of accident. Thus, for instance, the head of the femur would, in walking, be violently thrust upwards, as the elastic band would yield to an increased weight, were there no inelastic, unyielding band to prevent it; yet, it is obvious that this inelastic band does not interfere with the predetermined amount of tension to be exerted by the elastic one. (This amount of extension is determined and regulated as follows: Buckle the two bands unequally, *i. e.*, let the loop formed by the outside band be longer than that of the inside, and attach a weight to the latter. The number of pounds requisite to stretch the one loop to the exact length of the other represents the amount of extending force the instrument will exert, when exactly thus buckled, when applied upon the limb.

"I will add, that here the amount of extending force should be ascertained in every instance before fastening the splint upon the patient; this amount is not to be varied by altering, by means of the saw, the length of the instrument, but by adjusting the two bands.)" Dr. Davis says that the long splint is best adapted to the majority of cases. Some years ago he was in the habit of applying a shorter one, seen in Fig. 279, to the femur alone. This leaves the knee at liberty, and in so far is an accommodation to the patient, but otherwise is not so effectual.

In applying the splint "cut from a piece of adhesive plaster, spread

Fig. 280.

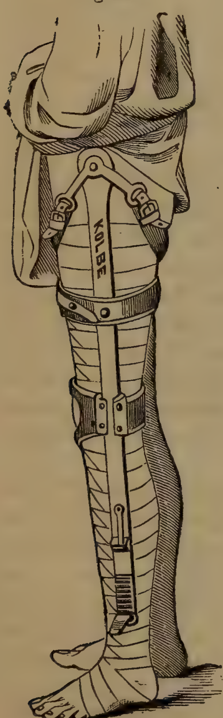


Davis's short splint for coxalgia.

on twilled goods, and kept until the oil entering its composition has become oxidized, two strips from one and a quarter to one and a half inches wide, of the length of the limb from the pubis to the malleolus, and two strips a little narrower in proportion to the others, but one and a half times as long. Fold about an inch and a half of one extremity of each of the first cut strips upon itself, the adhesive sides to each other, and apply one on the outside and one on the inside of the limb, commencing with the folded end about two inches above the outer and inner malleoli, and extending it up in a straight line.

"The other two strips are applied spirally around the limb as follows: Commence on the lower or folded extremity of the straight strip above the outer malleolus, and wind around in front and back, so that the two spiral strips meet in front, a little distance above the patella. Next, sew a piece of firm, *inelastic* (linen or cotton) webbing, about one and a quarter inches wide and six to eight inches long, to the lower extremity of each straight strip, taking particular care to include in the attachment the ends of both spiral strips above the external malleolus. The limb is then closely and firmly enveloped with a common roller bandage, from the foot upwards, the pieces of webbing only being left outside free. Now buckle the ankle portion of the splint upon the external face of the limb by means of the webbing; protect the skin of the groin and parts to be covered by the perineal band by a piece of old, soft napkin, or table linen, several times folded and secured by a few stitches; and having previously adjusted the two bands composing the perineal band, as already mentioned, fasten the latter around the thigh, always taking care to have the buckle on the pelvic portion of the splint in front; the screw of the splint regulates its length, so that the required amount of extension can be secured. When all is correctly arranged, and proper extension made, the upper extremity of the splint should fall just below the crest of the ilium."

Fig. 281.

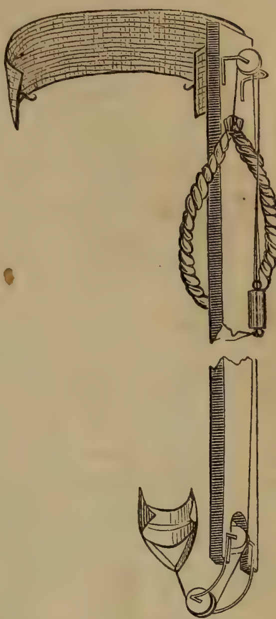


Davis's splint applied.

Dr. Lewis A. Sayre, of New York, has modified Dr. Davis's splint; he adds an inside splint, which is connected with the external one by a metallic stem arching across the limb; by this means extension can be made with adhesive strips applied upon both sides of the leg.

Mr. Richard Barwell, of London, has also carried out the principle of extension in the treatment of coxalgia by the ruder splint seen in Fig. 282. It is sufficiently simple to be extemporized by the surgeon

Fig. 282.



Barwell's splint for coxalgia.

without the aid of a mechanic, and it will, therefore, prove of service where the more elegant and efficient apparatus of Drs. Davis and Sayre are not at hand.

Mr. Barwell says that "the principle of its construction is to make a strong India-rubber spring, or accumulator, act as both extending and counter-extending force. For this purpose it is fastened by each end to a piece of catgut that plays round pulleys, attached to either end of the splint.

"The splint seen in the figure, though specially arranged for the hip, with suitable modifications may very easily be applied to any joint.

"A long Desault's splint is furnished at its upper part with a wire pelvic belt and a loop of strong wire, or of steel, which carries a small pulley, and which projects outwards about an inch and a half. The lower part is provided with a bar running across the space of the notch, and also carrying a pulley. From the lower end of the splint, projecting inwards an inch or an inch and a half, is another loop, carrying a third pulley. A perineal band, passing round the upper part of the limb and splint, has a piece of rather thin catgut (violin string A or D) attached to it, which going through the upper loop of wire runs round the pulley, is brought down on the outside of the splint, and is attached to one end of the India-rubber accumulator. Round the foot and ankle are fastened two pieces of webbing, which lace over the instep, and to both sides of which is sewn tape, forming a loop below the sole of the foot. This tape affords attachment to another piece of catgut, which plays over the pulleys, in the lower part of the splint, and is tied to the other end of the accumulator with the fitting amount of tension."

Adhesive strips applied to the leg may be advantageously substituted for the webbing in making extension.

In using the splint "the surgeon begins by applying a broad piece of strapping on either side of the leg, from the knee to the foot, allowing an inch or an inch and a half of the material to project below the sole; he then bandages firmly to the knee. . . . It is better to leave the patient some hours before any force is exerted on the strapping, that it may establish strong adherence. When it is supposed to stick sufficiently firm, the splint is to be placed in position; the upper portion will pass round the pelvis, the lower lie along the bed, quite out of reach of the distorted limb. The surgeon now bandages from the foot to the top of the thigh, independent of the splint; arriving at the latter place, he causes the bandage to pass round pelvis and thigh, including all the upper portion of the splint, thus fixing it with sufficient firmness. Catgut is now to be fastened to the ends of the plaster

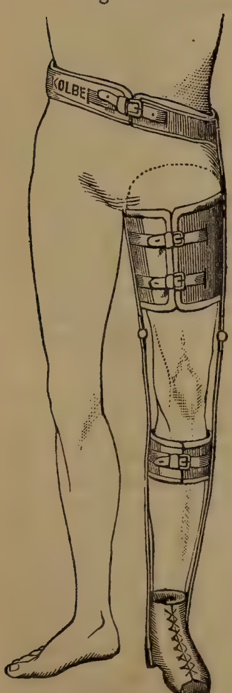
projecting below the foot; the perineal band, properly padded, is to be adapted, and both to be fastened to the accumulator with the proper degree of tension.

"For the first ten minutes or quarter of an hour, the strain should be slight; the muscles soon after its application set up a startled sort of resistance, which, however, soon subsides, and then the India-rubber is to be pulled tighter. In a few hours the foot or knee will have descended so much that a nurse, or some other person in attendance, must tighten the spring, and in from eighteen to thirty hours the limb will have come down, and may be bandaged to the thigh part of the splint. This will have been effected without pain or violence; indeed, the starting pains previously complained of will even abate under the downward traction.

"If, however, the malposture be more fixed—that is, if the disease be further advanced into the second stage—the thigh cannot be thus drawn down without producing considerable pain; and in such case it will be better to give chloroform, and while the patient is under its influence to draw down the limb into the proper position—namely, straight, and to bandage it upon the splint."

Dr. E. Andrews, of Chicago, has constructed an apparatus in which extension and counter-extension are effected by an inside splint made of gas-pipe. At its upper end a crutch-shaped support is placed working into the stem by means of a screw, to rest against the perineum and ischium; the corners of the crutch bear straps which buckle over the hip; the lower end of the splint is connected with the sole of the boot. The manner in which this instrument acts is sufficiently clear: the limb is extended by means of the screw, so that the joint surfaces of the hip are separated; while in standing the weight of the patient's body is supported upon the crutch and transmitted to the ground by the side splint.

Fig. 283.



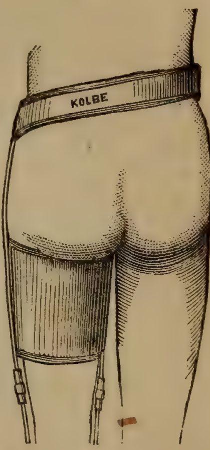
Agnew's apparatus for coxalgia.

Dr. Agnew, of Philadelphia, has also suggested a modification in the form of the apparatus, so that the perineal strap is done away with, and the weight of the body is sustained upon the perineum and ischium by the upper edge of a padded thigh-piece.

The contrivance, as seen applied in Fig. 283, consists of an outside metallic splint extending from a padded pelvic strap to the margin of the sole of the shoe; it can be lengthened or shortened at will, so that an appropriate degree of extension may be obtained upon the limb; from the obliquity of the pelvic strap it will be seen that it simply adds to the stability of the apparatus without assisting in any degree in exerting counter-extension, as will be seen in the instrument next to be described. There is also an

inside splint, constructed exactly in the same manner as the former, reaching from the inner edge of the shoe sole to the highest point of the perineum. The two splints are connected above by a well-padded thigh-piece, the upper margin of which should reach well up behind, as shown by the dotted lines in the figure, to press against the ischium; a second strap encircles the leg just below the knee.

Fig. 284.



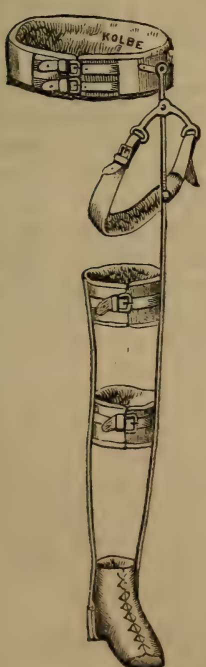
The same, posterior view.

The manner of fitting the thigh-piece beneath the buttock is seen in Fig. 284. It is exactly the same plan that has been pursued in the adaptation of the *bucket* of an artificial limb.

Another efficient instrument in the treatment of coxalgia will be found in the one of which the accompanying wood-cuts are illustrations (Figs. 285 and 286).

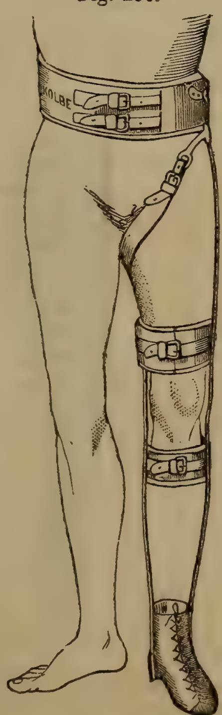
It is so constructed that the counter-extension or counter-pressure is divided between the elastic perineal strap, such as is used in Davis's splint above described, and a broad, padded pelvic strap; the latter portion, besides, confers greater firmness and stability upon the apparatus. The

Fig. 285.



Apparatus for coxalgia.

Fig. 286.



The same applied.

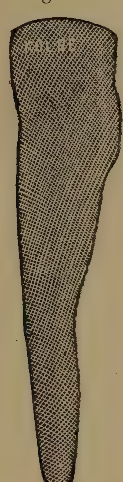
outside rod extends from the pelvic belt, to which it is attached by a ginglymoid joint, to the outer margin of the sole of a laced boot. This rod is made in two sections, movable upon each other, so that it can be elongated or shortened. An inside splint stretches from a corresponding point upon the internal margin of the sole of the boot to the middle of the thigh. The two rods are connected together by two well-padded metallic straps, one above and the other below the knee. The elastic perineal band is connected to the external splint by means of a small curved metallic stem, articulated with it in the same manner as in Dr. C. F. Taylor's modification of Davis's splint.

The mode in which this apparatus is applied is seen in Fig. 286.

It is necessary, in overcoming the contraction of the muscles, that the extension should be continual, and therefore, when the splint is not upon the patient's person, a weight, passing over a pulley at the foot of the bed, should be hooked to the extending band.

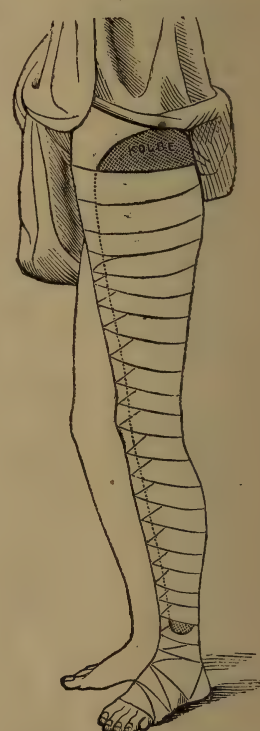
In the early stage of coxalgia, when there is no abnormal contraction of the muscles nor deformity of the limb, the application of the wire splint, seen in the annexed drawing (Fig. 287), will be found advantageous. It incloses the diseased hip and the corresponding thigh and leg, securing perfect immobility of those parts without interfering with the movements of the rest of the body, which is an advantage of no small importance in relieving the patient of much of the physical restraint and injurious influences of a protracted recumbency imposed by some of the couches and apparatus sometimes employed in the treatment of this disease, while at the same time it secures all the

Fig. 287.



Wire splint for coxalgia.

Fig. 288.



Mode of applying the wire splint.

good that can be conferred by them. The manner in which this splint is applied is very well shown in Fig. 288.

When the wire splint is not attainable, a less elegant, but yet no less efficient splint, may be prepared with plaster of Paris in the manner described under the section treating of fractures; and in several cases in which I have employed it, entire satisfaction was obtained. Gutta-percha and pasteboard may also be used for making the splint.

PART III.

FRACTURES: THEIR REDUCTION, DRESSINGS, AND APPARATUS.

CHAPTER I.

GENERAL CONSIDERATION OF FRACTURES.

Fracture may be defined to be a solution of continuity of a bone resulting from external violence or muscular action.

Up to the age of twenty-one, and even later, before ossification has been completed, the epiphyses may be separated from the shafts of the long bones, constituting what is called a "diastasis," which resembles fracture so closely in its causes and symptoms that it would be doing considerable violence to pathological analogy to consider the two injuries separately.

Classification.—When a bone is broken into two pieces, the fracture is said to be *simple;* when into more than two pieces, *multiple* or *comminuted.* A broken bone, communicating exteriorly through a wound, constitutes a *compound* fracture; a *complicated* fracture is accompanied with a dislocation, rupture of bloodvessels or nerves—or, indeed, with any other unusual and severe injury.

The terms *complete* and *incomplete* refer to the fact of the fracture running either completely or partially through the bone.

The line of fracture may pass through the bone parallel with its axis, at right angles to it, or in a direction between these two; this establishes a further division of these injuries into longitudinal, transverse, and oblique fractures. There are a few recorded examples of perfect longitudinal fractures, and they are generally the result of a gunshot. In other instances they are always accompanied with one of the other varieties.

In old persons, and those with very brittle bones, a transverse fracture may be encountered, though it will generally be accompanied with some little obliquity, yet not sufficient to permit the ends of the bone slipping beyond each other and overlapping.

Thus it appears that oblique fractures are, by all odds, the most common, and are those always observed in healthy and vigorous persons.

Occasionally it happens that one extremity of a fragment has indentations upon it which receive corresponding elevations upon the face of the other, forming what has been called a serrated fracture.

An *impacted* fracture results from one fragment being driven into the other and remaining fixed.

Malgaigne has proposed the introduction of the terms *single* and *multiple* to express the number of pieces into which a bone is broken.

Frequency.—The bones are not all equally liable to fracture; the clavicle suffers more frequently than any other in the proportion, according to the statistics of Malgaigne, of 360 in 900 of all kinds. The long bones of the extremities, particularly the upper, from their extended range of motion and great length of leverage presented to the action of external and muscular forces, are necessarily much more often broken than the short bones, which are at once limited in extent of movement, and more compactly bound together by short and strong ligamentous bands, and they are therefore less liable to suffer damage to their continuity by mechanical agencies.

CAUSES.—The causes of fracture may be conveniently divided into the predisposing and exciting; among the former class we find those diseases which sap the strength and constitutional forces, producing alterations in the organic integrity of the bones themselves—such as scrofula, gout, scurvy, rheumatism, syphilis, mollities and fragilitas ossium, and cancer. Old age, from the changes in the relative proportion of earthy and animal constituents of bone which accompanies it, is also a strong predisposing cause. Sex also has a certain influence, inasmuch as males meet with the accident more frequently than females in the proportion of 7 to 5; a difference, probably, depending upon the greater exposure of the former class of persons to the exciting causes of fracture in the pursuit of their peculiar avocations. On the other hand, aged females more frequently suffer from this accident than the corresponding class of males.

The exciting causes of fracture are two, namely, external violence and muscular action. External violence varies in intensity from a force just sufficient to break the bone to that excessive degree whereby the bones and soft parts are crushed and mangled frightfully, as is exemplified in railroad accidents and gunshot wounds.

When the bone gives way at the point where the violence is applied, the fracture is said to occur from *direct force;* and from *contre-coup*, or counter-stroke, when it takes place some distance from this point, as occurs sometimes when a person falls from a height upon his feet, breaking the bones of the leg.

A fracture may occur at any point in the continuity of the long bone, but most frequently it takes place in the middle third of its diaphysis; and more especially does it do so when the injury results from counter-stroke. The reason of this will be found in the fact that this section of the bone offers less resistance to the force than any other. There are other circumstances determining the point of breakage, such as the direction of the force, the position of the limb at the time of the injury, the connection of the bones with the adjacent parts; and lastly, the manner in which the force is decompounded and transmitted by the bones. In illustration of the last point, it may be mentioned that in those sections of the limbs possessed of two bones, the application of violence may fracture the latter at different

points, the larger bone below, and the smaller one at some point above. This fact is explicable when it is considered that in the arm and leg the radius and tibia form the larger portions of the wrist and ankle-joints; hence in falls upon the palms of the hand and soles of the feet, they receive and transmit a greater share of the force; from their size not being able to yield sufficiently rapid to the violence from below, this accumulates at a given point above the ankle and wrist, and a fracture ensues; the ulna and fibula, on the other hand, receiving and transmitting a less amount of force from their slighter connections with the joints, and yielding more rapidly than the large bones, do not give it a chance to accumulate sufficiently to damage them until it reaches a higher point, where the break will occur.

Violent muscular action less frequently determines fracture than external violence, and it is principally observed in the olecranon, patella, and os calcis. Malgaigne denied that muscular action alone was ever an efficient cause, in the long bones, without previous disease of their structure; but the recorded cases of such injuries prove irrefragably that this has occurred, not only in the humerus, maxilla, radius, ulna, and bones of the leg, but even in the femur—the largest and strongest long bone of the skeleton—without any precedent disease whatever. Though it can scarcely be doubted that in a majority of such cases the broken bones will be found to have undergone more or less morbid change of structure, so as to become brittle; this fact will also explain why it is that most of the fractures from muscular force approximate more or less to a transverse direction.

Some of the congenital cases of fracture have been attributed to the violent contractions of the uterus during parturition.

SYMPTOMS.—It is very important that the practitioner should study accurately the symptoms which announce and accompany fracture, for upon such knowledge the correct diagnosis of the case will depend; they are crepitus, preternatural mobility, deformity, deprivation of natural function, contusion, pain, and some constitutional disturbance.

Crepitus.—This is the peculiar sound produced by the rubbing together of the opposing fractured ends of a bone; it will be most evident in those cases where the fragments are not displaced, and are surrounded by a slight thickness of soft parts. Should the ends be impacted or overlapped, crepitus will not be heard at all, though in the latter case it may be developed by extending the limb. The mode of eliciting this sound, commonly adopted by the surgeon, is to seize the fragments in both hands and move them in opposite directions; in the thigh, the surgeon sometimes directs an assistant to rotate the limb, while he brings his ear near the seat of injury. These measures, as indeed in all other manipulations in fractures, should be accomplished with the greatest gentleness. Though crepitus may generally be both heard and felt, yet there are cases in which the surgeon is compelled to depend upon the latter sense alone; the impression communicated to the touch by crepitus may be obscure, yet with a little practice it may be discriminated from that produced by the rubbing together of cartilages or surfaces roughened by deposited lymph.

Preternatural Mobility.—This is observed when a bone is broken

clear through, and its ends not entangled with each other; if the limb is raised, that portion of it below the fracture may be moved freely in every direction. It will be evident, more or less, from the beginning of the injury to the time when consolidation of the fragments is about occurring. Preternatural mobility may also be present in dislocation in which there is extensive laceration of the ligaments, but may be distinguished from that of fracture by the characteristic symptoms of dislocation which accompany it.

Deformity manifests itself in several modes; when there is an over-riding of the fragments the limb will be shortened to an extent varying from one inch to three and a half inches, the average, perhaps, being about an inch. In impacted and partial fractures, particularly the latter, shortening may not be at all apparent; we may also mention those cases in which the line of breakage is so nearly transverse that the ends of the bone remain in contact. The shortening in fracture can almost certainly be diagnosticated from that encountered in dislocation by the fact that in the former case moderate extension causes the deformity to disappear, and as soon as the force is withdrawn the shortening recurs; exactly the reverse is generally true in dislocation. The causes of shortening are, first, the violence which produced the injury driving the ends of the pieces of bone past each other; secondly, muscular contraction, which brings about the same result more constantly, and against which art has most to struggle in opposing deformity, while the patient progresses to convalescence.

The limb may also be curved or angular at the point of fracture by the lateral displacement of the fragments, and indeed there may be actually a doubling of the limb upon itself, as I saw in several cases during the rapid transportation of the wounded after a disastrous repulse in attacking a fort.

Another form of deformity results from the rotation of the lower fragment of a broken bone upon its axis, which is so frequently seen in fractures of the femur in consequence of the weight of the limb below the point of injury.

Deformity may occur immediately upon the infliction of the violence or after the lapse of several days.

Deprivation of Natural Function.—It may be readily conceived that a patient with a fractured limb may not be able to raise it, or to support the weight of the body upon it, since the bones cease to furnish that powerful leverage indispensable to the muscles in the exercise of their functions; besides, the muscles are generally so much bruised and sore that a patient cannot often summon the required amount of courage to make such efforts. This loss of function, though a striking feature of fracture, is yet not invariably present; the fragments may be impacted when the injury occurs in the neck of the femur, or only one of the two bones composing the leg may be broken, in which instances a person may be able to walk some distance, and it is even stated that when both the tibia and fibula are broken progression may not be impossible. In the case of fractured clavicle a person can perform the movements of circumduction and place the hand upon the top of his head.

Contusion.—In all cases of fracture there is more or less contusion of the soft parts, producing rupture of the bloodvessels, and subsequent effusion of blood, followed by inflammation, swelling, and effusion of serum. These concomitants sometimes render the diagnosis difficult, if not impossible, by preventing the fingers of the surgeon coming in sufficiently close proximity with the bone to ascertain its condition.

Pain.—This symptom is rarely absent in any case of fracture, and is commonly felt at the seat of the injury; it is aggravated by pressure or the slightest movement of the limb, and in nervous subjects is not unfrequently accompanied with spasmodic action, which entails often the most horrible suffering upon the patients. The cause of pain is the tearing or bruising of the soft parts, and consequent laceration of their nervous filaments by the broken ends of the bone. From the concussion of the nerves a numbness is produced at the seat of the injury, and in some cases the whole limb may suffer in the same manner, or a patient may complain of numbness over the entire body, either at the time of injury, or after the lapse of several days.

Constitutional Disturbance.—The constitutional disturbance following fracture varies with the violence of the injury and the extent of damage done the body, from a scarcely noticeable febrile movement to great nervous perturbation and excessive febrile reaction.

Diagnosis.—Fractures have been confounded with sprains, dislocations, several diseases of the joints, necrosis, and caries. Should the injury be located near the diaphysis of a bone, the diagnosis will generally be easy; while, on the other hand, when it is near the joints, there is often great difficulty encountered; it is in such cases that the greatest experience and skill are necessary to rightly elucidate the nature of the injury. In all cases the practitioner will require a thorough knowledge of the above detailed symptoms, which, taken in connection with other circumstances, such as the history of the case, age of the patient, mode in which the injury was inflicted, &c., will enable him to come to a correct decision.

Prognosis.—The surgeon should be governed in his prognosis of a case of fracture by the knowledge he has of the amount of injury inflicted upon the soft parts; whether the fracture is simple or compound, or complicated with rupture of bloodvessels, of nerves, or of tendons; any of these conditions rendering the case much more serious. A partial or an impacted fracture is more favorable for the ultimate restoration of the function of a limb than the other varieties; so a transverse fracture will heal with less deformity than an oblique one. The prognosis will be more grave the nearer the injury is to the larger joints; fractures of the upper extremities unite more quickly than those of the lower. Young and healthy persons recover more frequently and rapidly than those broken down by disease, intemperance, and age.

Mode of Repair of Fractures.—The recuperative efforts of nature proceed in the repair of broken bones in the same manner as they do in that of the soft tissues, modified of course to some extent by the peculiarity of their composition in containing such an abun-

dance of the calcareous salts. There may be an effusion of plastic matter around the ends of the bone, which is subsequently converted into bone, or the consolidation may occur by a process analogous to that of immediate union. The mode pursued will, in a considerable degree, depend upon the relations of the ends of the broken bone to each other, their mobility, the extent of the complications of the injury, and whether the injured bone is shut in from the air or not. According to the investigations of Mr. Paget, of London, the old views of Dupuytren, that a provisional and definitive callus were necessary and always present in the course of the healing, are no longer tenable. In a few exceptional cases no callus is formed, nor even lymph thrown out, but the bone appears to unite immediately by the re-establishment of the continuity of the bony fibres and bloodvessels. The reparative process does not begin before the eighth or twelfth day after the injury; during this period of apparent rest the inflammation diminishes, any effused blood which may have been poured out among the tissues, and which rarely takes any share in the healing, is gradually absorbed, and along with it, in the most favorable cases, the inflammatory lymph also disappears. At the expiration of the above stated time, when these fluids have been more or less cleared away from the neighborhood of the fracture, the proper reparative materials are extravasated, by the organization of which the reunion of fractures is commonly effected. This plastic matter does not appear to differ from the material furnished for the healing of the tendons subcutaneously. It is a "structureless or dimly-shaded granular substance, like fibrin; or perhaps, at a later period, it is ruddy, elastic, moderately firm, and succulent, like firm granulation substance." This matter is placed in various positions as regards the broken ends of a bone, but two principal modes have been observed: first, it incloses them like a ferule, and is then called the *provisional* or *external* callus, and by Mr. Paget the *ensheathing* callus; secondly, the matter is laid between the surfaces of the bone in contact with each other, or in the angle formed by one fragment overhanging the other, when it is named the *intermediate* callus. The former plan is rarely observed in the human subject, except in those bones, such as the ribs, which must necessarily be in continual motion, and also in children, in whom it is difficult to keep the limbs quiet during the period of ossification of the broken bone; while it is the common mode of repair in animals. The callus usually extends about a half inch above and below the plane of fracture, and presents a constricted appearance about its middle. It commonly lies between the bone and periosteum, raising that membrane from contact with the surface beneath.

The interior *callus* fills up the cells of the medullary canal, extending above and below the plane of fracture a distance somewhat short of that of the external callus. When the callus is well formed, the bone may be restored to its former usefulness, although its walls yet remain ununited, which requires a lengthy period, perhaps as much as eight months in a long bone; and not until the expiration of this time are the materials, that have gone to form the callus, absorbed, leaving the surface of the bone smooth and uniform.

The second plan of union, or that by an *intermediary* callus, is the one commonly observed in man; the reason of this is to be found in the fact that the fractured limbs of persons, with the exception noted above, are kept in greater quietness during their care than can be obtained in inferior animals. An additional reason is, that man possesses a much less disposition to ossific formation than animals. The reparative matter is not only deposited between bony surfaces in contact, but it may extend also between those separated by a considerable interval.

The process of ossification may take place in one of three manners. That commonly observed in adult long bones, in favorable cases, is by means of a nucleated blastema, a sort of rudimental fibrous tissue. In compound fracture the new bone may be formed by ossification of the nucleated cells of the granulations. In other instances the reparative materials may pass through an intermediate state either of cartilage or of fibrous tissue; the former plan being sometimes observed in children, but rarely in adults; and it appears to be the common mode of ossification in animals.

In whatever manner ossification may take place, by a subsequent process of absorption the injured bone is modelled, as it were, into its normal shape; its exterior surface is bevelled and smoothed, while the cells of the cancellated structure are cleared of the interior callus, until they form the natural and continuous medullary structure of healthy bone, shut in by the new walls of compact tissue.

The periods occupied by these several parts of the reparative process have not, as yet, been accurately determined, but the following may be regarded as approximations to the truth: Eight or ten days elapse before the proper materials are poured out; from that time to about the twentieth day these become converted into a fibrous or cartilaginous condition, when bone begins to appear, and continues to be deposited until ossification is complete, which, though exceedingly variable as to time, is rarely less than sixty or seventy days.

UNUNITED FRACTURES.—From constitutional or local causes the process of repair may fail, and the fragments of bone will not be united at all, or perhaps by a fibrous or fibro-cartilaginous tissue, forming what has been called a pseudarthrosis, or false joint. The ends of the bone will generally be found rounded off, and covered with a layer of dense fibrous tissue, or a cartilaginous incrustation, constituting a structure somewhat analogous to a joint; sometimes there is a bursal sac developed between the bones. In other cases, instead of a false joint being formed, the whole of the diaphysis of the bone may be absorbed.

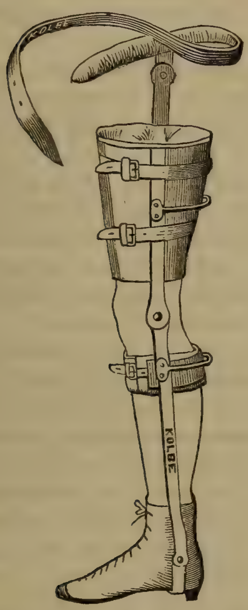
Treatment of Ununited Fracture.—In this place the apparatus only which have been found useful in the treatment of false joint will detain us, inasmuch as the various surgical procedures of seton, cauterization, acupuncture and resection, are more properly treated of in general works on surgery.

The common object of all bandages or apparatus, in these cases, is to make pressure upon the broken extremities of the bone, and to support the limb rigidly, so as to cause a sufficient amount of irritation

about them as to lead to an ossific deposition in the false joint. The compression may be effected by some of the apparatus to be described further on; the main point to be attended to is, that the pressure shall be firm, continuous, and uniform.

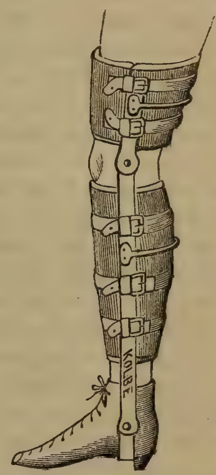
For ununited fracture of the lower extremities, Prof. Henry Smith, of this city, has recommended the apparatus seen in Fig. 289. It consists of two metallic side rods, the outer one extending from the shoe to the hip, and the inner one reaching to the perineum, connected together by long thigh-splints, straps and buckles. The rods are provided with joints at the hip, knee, and ankle; a

Fig. 289.



Smith's apparatus for ununited fracture of the femur.

Fig. 290.



Smith's apparatus for ununited fracture of the leg.

pelvic strap is connected with the upper extremity of the outer rod. When the apparatus is applied, the patient is enabled to take out-door exercise, which will materially contribute to a successful issue. Of similar construction is Dr. Smith's apparatus for ununited fracture of the leg (Fig. 290). It possesses the same advantages as the previous instrument in sustaining the fragments of the bone immovable, while the patient bears his weight upon the limb, and moves around in the open air.

Both of these are elegant contrivances, and of real utility in the treatment of ununited fracture; they deserve a continuous and faithful trial before any severe surgical procedure shall be had recourse to to effect the consolidation of the fracture.

In absorption of the diaphysis of the bone, an apparatus taking its bearings above and below the point of fracture, by means of two cir-

cular and well-padded metallic straps connected laterally by two side-rods, may be employed with advantage; in the arm, for instance, the upper strap may be applied below the shoulder, and the lower one just above the elbow, while the side-rods will retain them sufficiently far apart, and at the same time give enough rigidity to the limb to enable the extensor and flexor muscles to act to an advantage.

Sometimes, from bad treatment or other causes, the pieces of bone may unite at an angle, or in such a manner that deformity will follow. In this case the judicious use of mechanical contrivances will accomplish a great deal in restoring the limb to its proper shape and usefulness. An appropriate instrument in such instances has already been described in Part II. The principle involved in its use is to bring direct pressure upon the top of the arch formed by the crooked line, while its extremities serve as points of counter-pressure.

COMPOUND FRACTURES.—In our previous observations we have principally alluded to simple fractures, and it will not, therefore, be inappropriate to introduce a few remarks here concerning those which are compound and complicated. Fortunately, this class of injuries forms a very small proportion of those fractures the surgeon is called upon to treat; they are most commonly observed in the leg and thigh, and are often attended with violent inflammation and suppuration, demanding total abstinence from the application of apparatus in the beginning of the treatment; the limb being simply placed in the most comfortable and advantageous position upon pillows and cushions to facilitate the application of the dressing and the cleansing of the wound. The reduction should always be accomplished, if it is practicable, immediately after the injury; if the bone protrudes from the wound, an effort should be made to restore it to its natural position by making gentle extension; while the surgeon may facilitate the operation by stretching the orifice with his fingers, or a wooden spatula. When these efforts fail, then nothing remains but to enlarge the wound a little with the scalpel; or, better, to saw off the projecting bone.

Once the reduction is accomplished the wound must be brought together so as to exclude the air if possible, and place the injury under the conditions of a simple fracture. If the case does not do well, and pus forms, the wound must be again opened to permit the matter to have a free escape externally.

To make gentle compression upon the parts the most elegant and convenient bandage is that of Scultetus; warm or cold water-dressings may then be applied according to the feelings of the patient. My experience during the war with bad compound fractures led me to abandon almost entirely the use of cold water in these cases, for the reason that it appeared to lower the vitality of the parts already bruised, and disposed them to slough. After the inflammation has abated, in a few days extension may be made by a weight attached to the leg by two lateral strips of adhesive plaster running up its sides and hanging over the foot of the bed.

When the inflammation and suppurative action have still more decreased, there will be no objection to treat the case with the apparatus employed in simple fracture. Indeed, in ordinary cases of com-

pound fracture the apparatus may be immediately applied, taking care that the bandages be sufficiently loose to allow for subsequent swelling, otherwise dangerous results may occur in the shape of mortification from excessive pressure.

The complications of this class of fractures are pyæmia, erysipelas, and tetanus, which are to be treated upon principles applicable to those diseases.

Complicated Fractures.—Should a dislocation accompany fracture, every means should be safely tried to effect the reduction of the dislocation first, by pressing with the fingers upon the upper fragment, accompanying it at the same time with proper manipulation of the limb, which may be rendered still more manageable by fastening it with straps, or a roller, to a board extending beneath its whole length; if these means succeed, the fracture may then be reduced in the usual way; on the contrary, if they do not, the limb should be placed in the best possible position for union of the bone to take place in a right line. When consolidation has been completed, gentle attempts may again be made to reduce the dislocation by manipulation, but at this period of the case success will rarely reward the surgeon's efforts.

The complication of rupture of bloodvessels and nerves, and extensive lacerations of the soft tissues, are to be treated by measures appropriate to those injuries, the former accident requiring ligature, and the latter the use of sutures and adhesive strips.

General Treatment of Fractures.—In the treatment of a fracture it should be a surgeon's first care by a scrutinizing, minute, and carefully conducted examination to find out exactly what the condition of the bone may be. The greatest tenderness and expedition compatible with the ascertainment of the desired information, should be exercised, for any improper or rude manipulations not only inflict uncalled for suffering upon the patient, but they also materially influence his subsequent recovery. It will be the best plan, when any lengthy examination is necessary, to put the person under the influence of chloroform, which will not only obviate pain, but will secure the additional advantage of enabling the surgeon to make a more thorough examination unopposed by the struggles of the patient or the contraction of the muscles. When the fracture is clearly made out the indications of treatment are to be fulfilled; of these there are three principal ones which naturally present themselves: first, to reduce the fracture; second, to retain the fragments of the broken bone in a proper position after the reduction; third, to counteract subsequent complications.

Reduction.—It was formerly a question among surgeons as to the proper time for reduction; whether to wait for the inflammation and swelling to subside before manipulative interference, or to proceed with the manipulation immediately. The general experience of the ablest surgeons in Europe and America have decided the latter plan to be the best, and it is the one now almost universally practised.

The means for accomplishing the reduction are, first, extension and counter-extension employed conjointly; and second, coaptation. Extension is the force applied to the lower fragment of a broken bone,

and counter-extension is the opposing force acting in exactly the contrary direction; coaptation is merely the kneading and pressure upon the soft parts about the injured point, exercised with a view of shoving the fragments into their normal situation.

The opinions of surgeons are somewhat different as to the exact points to which the extending and counter-extending bands should be affixed. English writers commonly recommend that they be applied directly to the fragments themselves some distance above and below the place of fracture; while the French surgeons deem it more advantageous to place them upon those sections of the limb connected with the fragments above and below.

The advocates of the first method contend that by their plan a more effective and direct force can be brought to bear; while those of the second method, admitting the advantage gained by applying the bands in this manner, urge that at the same time that greater force is exerted, the muscles will be stimulated to stronger contractions by the local irritation thus caused, which will more than counterbalance the gain in power.

The truth in this, as in most questions of the kind, lies midway between the extremes, and the judicious surgeon will use one or the other plan as best suits the exigencies of the particular case he is called upon to treat. During the efforts at reduction the limb should be held in that position which most thoroughly relaxes those muscles opposing the replacement of the fragments in their normal situation; usually one of moderate flexion will be found the best.

The two forces, extension and counter-extension, should at first be made in the direction of the axes of the fragments upon which they act; that is, in the direction of the displacement; when the ends of the bone are in this manner disentangled the forces must be brought to bear in a straight line until the reduction is accomplished, which should be furthered by pressing with the fingers upon the displaced pieces.

If the fracture is transverse, it can readily be imagined how the reduction may be effected and consolidation of the bone obtained with little or no shortening of the limb; but the case is different in oblique fracture in which it is almost impossible by any manipulation to bring the fragments into exact contact, and sustain them until the repair is effected, without more or less shortening. In fifty cases of which I have notes, of gunshot fracture of the long bones, the shortening varied from one inch the minimum, to four and a half inches the maximum. The next object after the reduction has been accomplished, is to maintain the fragments immovable until union occurs. Opinions of surgeons as to the best position in which the limb should be placed to secure this result have varied. The straight posture was recommended by Hippocrates and generally practised by surgeons until the eighteenth century, when Broomfield and Pott advised and practised the plan of keeping the limb flexed. The former method has met with many able supporters, both in Europe and America, and in the latter country I believe it is most commonly pursued, except in fractures of the lower third of the femur. These remarks, of course,

apply to fractures of the lower extremities; for, perhaps, with the exception of fracture of the olecranon, all injuries of this kind in the upper extremities are treated in the bent position. From a remote period surgeons have sometimes employed certain mechanical contrivances or machines to effect reduction, such as the bars of Hippocrates, the plinthium of Nileus, the glossocomes of Galen and Paré, and in later times the adjuster of Jarvis, but in this class of injuries these are entirely unnecessary, inasmuch as no greater amount of force is required than can be exercised by the natural powers of the surgeon and of his assistants.

Retention.—There are great difficulties encountered in fulfilling the second indication; position will accomplish something, but the greatest dependence must be put upon properly constructed appliances, of which there are a great many varieties. There is perhaps no branch of surgery in which more genius has been displayed in invention than in this one, and it will, therefore, be proper to devote some space to a consideration of the general features and character of the apparatus that are now employed.

Splints are the most indispensable and important means used in the treatment of fracture. To adapt them to the great variety of injuries of this nature occurring daily, they are required to be made in various forms, of different sizes, and of several materials.

Wooden splints, of all others, from their general utility, efficiency, accessibility, and simplicity of construction, have always and do now enjoy the largest share of professional patronage, and this is truly well deserved when we consider the ease with which any person may, with a knife and a piece of soft white pine, linden, or any such light strong material, prepare splints well adapted to the treatment of most any case of fracture in which splints are needed. An additional recommendation is, that these materials may be obtained without cost, and are to be found very conveniently at hand.

In these encomiums we do not wish to be understood as including those carved splints furnished by surgical instrument-makers and bandagists; but should this description of splint be desired, the surgeon should superintend its construction in order that it may be adapted to the case in which it is to be used, for it would rarely happen that any one of these contrivances would possess that form and size adapting it to the treatment of a case for which it was not made.

As to the matter of form, splints vary: some are straight, as those of Desault for fracture of the femur; some angular or curved, as Physick's splint for the elbow; others are shaped to resemble the outlines of the part to which they are applied, as Pott's splint for fracture of the leg, the palette, and foot-board; while a third class are grooved in various degrees to fit the irregularities of parts. Splints may also be entire, or notched or perforated to enable the turns of the roller or other fastenings to be more effective in holding them to the limbs.

The size of splints is a matter of importance both as regards their neat appearance and effectiveness; for when they are clumsy the general appearance of the dressing will be marred and they cannot be

so securely or accurately fixed to the parts beneath. Those materials should be selected which, when reduced to the lightest and thinnest laminæ possess a sufficient degree of toughness and strength to maintain the limb immovable; the thinnest splints need rarely to be less than one-sixth of an inch nor the thickest more than three-eighths of an inch upon their edge. Their width should be sufficient, as a general rule, to prevent the bandage pressing upon the edges of the limb between them, which might displace the fractured bone; a result that has not unfrequently happened in putting splints on the forearm. Their length is also to be carefully attended to; in fracture of the lower part of the fibula and of the upper third of the humerus, if the splints are too short, as I have seen them applied, they do not serve the purpose for which they are intended.

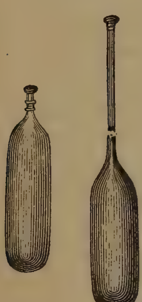
Besides wood, splints may also be made of horn or whalebone, or the tough inner bark of various trees, which, when dipped in hot water are susceptible of being moulded to the limbs with accuracy. In cases of emergency, the flexible twigs of trees, thin reeds or straw rolled up in a piece of cloth, will also supply good splints.

Pads are usually prepared for splints of chaff or bran, inclosed in sacks of the proper length and width; these materials make cooler and more easily adaptable cushions than wool or curled hair, which are sometimes used. Another convenient and neat plan is to inclose the splint in a little sack, leaving one of its ends open, through which cotton-batting is stuffed, until a sufficiently thick cushion is obtained upon one side of the splint, when the mouth of the sack is sewed up. A more expeditious method still is to lay the cotton-batting upon a splint and inclose them both with a roller bandage.

M. Gariel has recommended the employment of air-cushions, made of India-rubber, which may be inflated through a tube connected with them to the desired extent. Fig. 291 shows these pads separated from the splints. Fig. 292 represents the cushions connected with the splints, and applied.

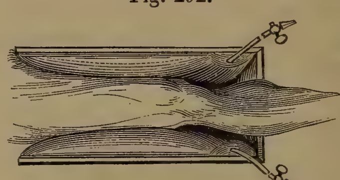
Pasteboard is a cheap, efficient, and widely diffused substance, to be found in every house in some shape or other, paper boxes, bandboxes, etc., and is well adapted to the preparation of splints. It is thrown into commerce by the manufacturer, made of different sizes, from No. 1, the frailest, to No. 10, the stoutest article; for the lower extremities No. 7 will be sufficiently stiff to make splints of; and for the upper extremities No. 4 or 6.

Fig. 291.



Air-cushions for splints.

Fig. 292.

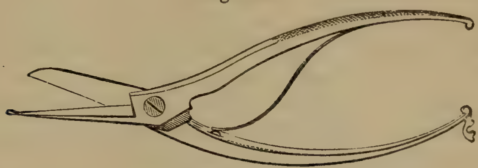


The same applied.

The method of preparing these splints is altogether simple, and

with a little experience a very good mould of any portion of the body may be obtained. The pasteboard is dipped in hot water until it is sufficiently soft to be moulded to the surface, to which it is confined by a roller bandage; when nearly dry the pasteboard is removed, and properly trimmed by a pair of shears, or, better, by the instrument invented by M. Seutin for this purpose (Fig. 293).

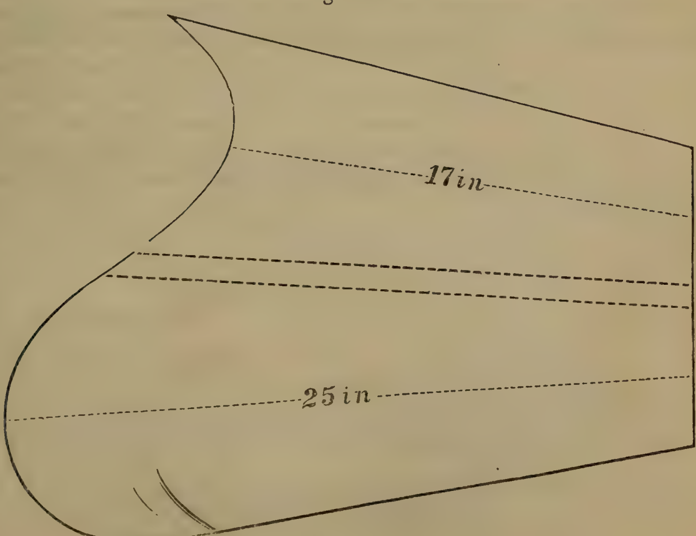
Fig. 293.



Seutin's pliers.

To make the most perfect models in pasteboard M. Mercie (Mercie, *Appareils modelés, ou nouveau système de deligation*, Gand, 1858) has proposed to obtain an exact pattern of each extremity by projecting upon a flat ground those curved surfaces which determine its outward configuration; for instance, in procuring a projection of the lower extremity he selects a person of average stature, and applies a roller bandage from the toes to the groin, where a spica is formed, a solution of starch is smeared over this, and a second roller is laid on in the same manner as the first, then more starch. When the bandage is quite dry it is removed by an incision extending from a point midway

Fig. 294.



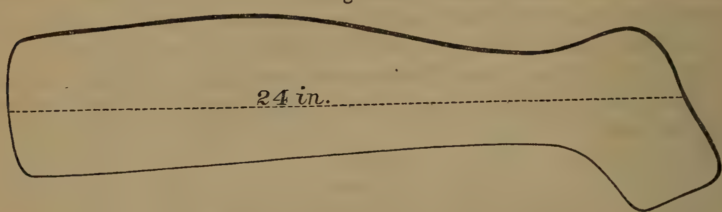
Horizontal projection for making splints for the thigh.

the dorsum of the foot to the middle of Poupart's ligament; the model is then moistened with a wet sponge, spread out upon a large sheet

of paper, and its margins traced out with a lead pencil. A line drawn from the apex of the heel to a point over the ischium will divide the bandage into an external and internal splint; if a piece two inches wide be cut from the middle of each of these, four splints will be formed, two for the thigh, and an equal number for the leg, so that they may be used singly or combinedly, according to the judgment of the surgeon or the necessities of the case. In the same manner, a projection may be made of the upper extremity. Now, from the horizontal projection, or outlines traced upon the paper, any number of splints may be proposed. Fig. 294 shows the projection of the thigh; the external splint for a person of average height will measure in its perpendicular twenty-five inches, and the inner one seventeen inches; for heights above and below this it is only necessary to increase or diminish the paper pattern with the scissors.

Fig. 295 shows a projection of the leg; the length of the pattern is twenty-four inches.

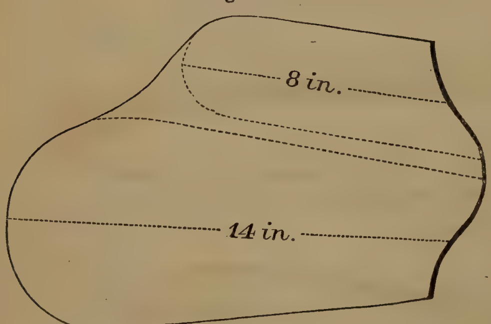
Fig. 295.



Horizontal projection for making splints for the leg.

In Fig. 296 the pattern for the arm is shown, taken from a starch bandage, which has been divided from the apex of the olecranon to the posterior extremity of the fold of the axilla posteriorly, and from the middle of the bend of the elbow to the acromion anteriorly; the outer pattern is fourteen inches, and the inner is eight inches long.

Fig. 296.



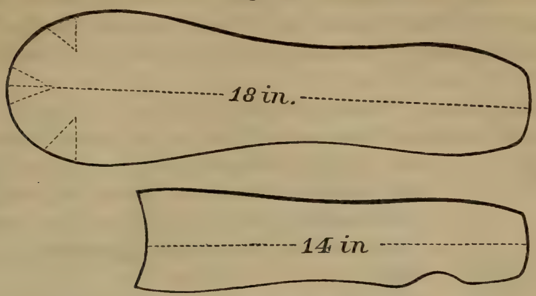
Horizontal projection for making splints for the arm.

The projection of the forearm is obtained from a starch bandage extending from the roots of the fingers to the elbow, and removed by two incisions, one along the radial, and the other along the ulnar border of the forearm; when these are spread out and traced upon paper, they give the appearance seen in Fig. 297, the posterior pattern being eighteen inches long, and the anterior one fourteen inches.

After the pasteboard splints have been cut upon these patterns they are immersed in warm water, and when sufficiently soft are

drawn out and moulded accurately to every point of the surface which they are intended to cover, with the fingers; a roller bandage

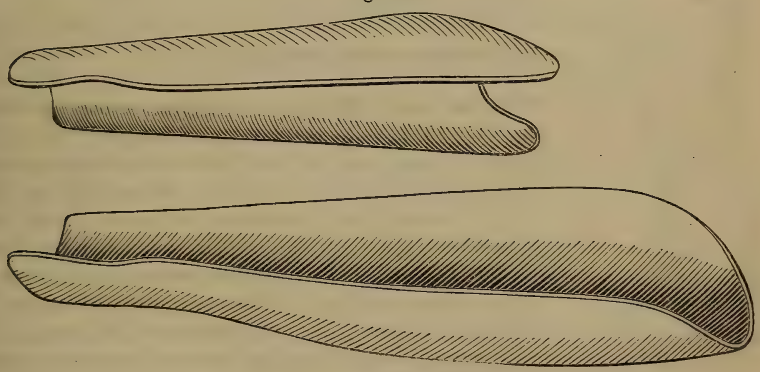
Fig. 297.



Horizontal projection for making splints for the forearm.

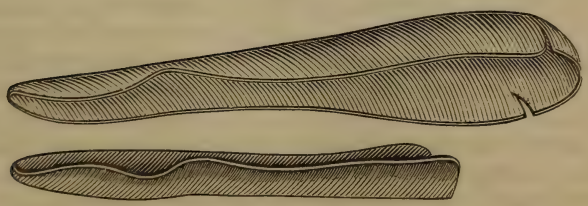
is then applied to hold the splints in contact with the skin; at the expiration of an hour or two the splints will be sufficiently dried to retain their shape, when they are to be removed and placed in an upright position before the fire, or in a current of air to insure their thorough desiccation. Should any wound exist, that part of the pasteboard corresponding with it may be first softened, and then removed with the shears.

Fig. 298.



Pasteboard splints for the thigh.

Fig. 299.



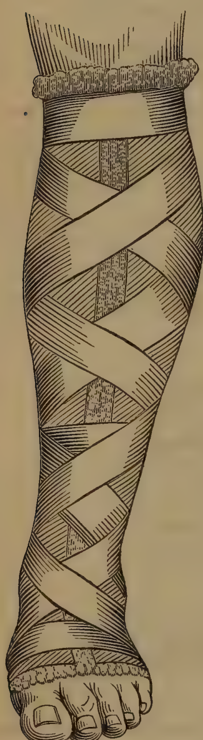
Pasteboard splints for the forearm.

Fig. 298 shows the appearance of splints prepared upon these models for the thigh, and Fig. 299 those for the forearm. They form

accurate moulds of the limbs, and, when properly padded and applied, nothing can be better for retaining the reduction of fracture than they. Any fear of their strangulating the parts by inordinate pressure, when applied as shown below, may be entirely dispelled, inasmuch as the surgeon has the limb beneath his observation constantly, and can regulate at his pleasure the amount of pressure he designs the splints to make.

The splints having been prepared, they are applied by placing within them layers of cotton-batting so as to form a soft bed, upon which the limb reposes; a roller bandage, or a few strips of elastic ribbon, will suffice to maintain the splints in their proper position. The mode of applying the apparatus is seen in Fig. 300.

Fig. 300.



Mode of applying a pasteboard splint in fracture of the leg.

Gutta-percha is now furnished the surgeon, rolled in sheets from a sixteenth to a quarter of an inch in thickness; the thinner ones will be required in fractures of the smaller bones, while for the larger bones, sheets from an eighth to a quarter of an inch thick are necessary. Should the article be only attainable in masses, it may be softened in warm water, and made into sheets by kneading it with the fingers and afterwards rolling it out with a cylinder of wood.

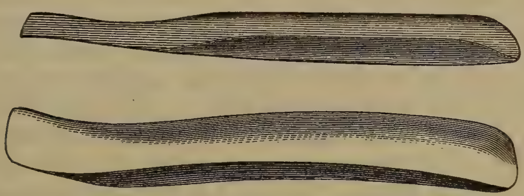
It requires a good deal of tact to make a neat and serviceable gutta-percha splint; for the material, immersed in warm water too long, becomes very soft and difficult of management, sticking to the fingers or anything it touches. I have usually pursued a plan, in manipulating with gutta-percha, similar to that described by Dr. Hamilton in his *Treatise on Fractures and Dislocations.* He says that "when constructing from this material a thigh-splint, we should order a very large tin pan, or some open flat tray, in which we may lay the splint at full length. If the splint is required to be twelve inches long, and six wide, we must cut it about sixteen inches long by eight wide, so as to allow for the contraction which always takes place more or less when the hot water is applied. It is then to be laid upon a sheet of cotton cloth of more than twice the width of the splint, in order that the cloth may envelop it completely when it is folded upon it; and the cloth should be enough longer than the splint to enable us to handle and lift it by the two ends without immersing our fingers in the hot water. Besides, if the gum is not thus covered and supported, it will adhere to the vessel, to the fingers, to the surface of the limb, and indeed to whatever else it may come in contact with; it may even fall to pieces, or become very much stretched and distorted by its own weight. The cloth cover will gene-

rally adhere to the splint, and may be permitted to remain upon it permanently.

"Place the splint, thus covered, in the basin, and pour on the water at or near the temperature of boiling. As soon as it is sufficiently softened, lift it carefully, and lay it over the limb, and by its own weight it will adjust itself to the surface, or it may be moulded with the hands or by pressing it against the limb with a pillow. If it does not harden rapidly enough, this process may be hastened by sponging the outer surface with cold water; and as soon as it has acquired sufficient firmness to support itself, it may be removed and immersed in a pail of cold water or placed under a hydrant; after this, it is to be neatly trimmed and dried, when it is ready for use."

Benjamin Welsh, of Lakesville, Conn., has made quite convenient splints by covering both sides of the gutta-percha with thin flexible laminæ of wood; they may be accurately adapted to the surface by softening them in hot water. By frequent use, the wood is apt to separate from the gum, and the splint becomes worthless. Fig. 301 shows Welsh's splints for the forearm.

Fig. 301.



Welsh's splints for the forearm.

Very neat and strong apparatus may be prepared with paper in the following manner: Take of coarse, porous paper, of any kind, a large sheet, and, having spread it out upon a table or any flat surface, rub into its interstices a solution of starch, and repeat the process upon the other side; then cut the sheet into strips from eight to twelve inches long and two inches wide. To apply them, first shave the surface of the fractured limb thoroughly, and, after the fracture is reduced, envelop it in a layer of cotton-batting, which is held in its place by an assistant or by a few threads tied around it, while the surgeon puts on the starched strips from below upwards, each overlapping a third of the width of its predecessor, after the manner of the bandage of Scultetus, until the whole limb or the desired extent of surface is covered. Lay over these three or four vertical strips, placed at equal distances apart, and then another circular layer; thus alternate the direction of the strips three or four times, or until the splint shall have acquired sufficient strength to answer its purpose. In twenty-four hours the apparatus will be hard and dry, though it will be well to provide against possible accidents during the intervening time by applying two lateral splints and a roller bandage. Its removal may be accomplished by dividing it into lateral or antero-posterior sections with Seutin's pliers.

Sole-leather makes an excellent splint; it softens readily in water, may be easily moulded to the limb, and, desiccating, forms a hard, resisting shell. The splint may be cut out of the leather upon the patterns already described for making pasteboard splints. After the action at Wilmington, N. C., I applied the leather splints to some ten or twelve cases of fracture of the arms and legs, with gratifying results.

Another form in which leather is used is to glue to a sheet of buckskin a thin lamina of wood, and, after it is dried, the wood is cut in narrow strips. This makes the most unsatisfactory apparatus possible; it can neither be neatly nor accurately applied to any surface, at least those that I have tried, contained in the allowance table of the Medical Department of the Navy.

Felt, or any sort of old stout cloth, saturated with a solution of shellac, containing half a pound of this gum dissolved in a quart of alcohol, and dried, will also make good splints at little expense. The following method may be pursued in their preparation: Lay the cloth upon a flat surface, and with a brush give it a good coating of the solution, which should then be thoroughly dried in a current of air; after which three or four more applications may be made in a similar manner. The cloth is now to be folded upon itself, and pressed with a hot flat-iron until its sides adhere; repeat the doublings and ironing three or four times, when the requisite thickness will be obtained.

To apply such a splint, first reduce the fracture; and having softened shellaced cloth in hot water, lay it upon the limb, previously swathed in a layer of cotton-batting, and press upon it with the hands in every direction until it is closely in contact with the surface; then put a roller-bandage over it. The adjustment of this splint should be quickly done, as it hardens in ten or fifteen minutes.

The "moulding tablet" is a name given by Mr. Alfred Smee to a contrivance of his prepared in the following manner: Take a piece of coarse old cotton cloth; spread it on a table, and apply to its surface, with a brush, a mixture prepared by adding common whiting to mucilage of gum-arabic, until the latter has acquired the consistence of thick paste; then double the cloth upon itself, and permit it to dry, when a tough, hard board will result, well adapted for making light and strong splints. In using them they are to be softened with hot water, squeezed from a sponge.

The common glue, melted in the usual manner in a kettle, and when cold having about a fifth part of its bulk of alcohol added, will form a good elastic and durable bandage. It may be applied in the following manner: Envelop the limb in a layer of cotton-batting, over this put a roller-bandage from below upwards, which is then smeared with the glue; another roller is placed over this, and glued in the same manner as the first; a third roller is applied, and coated with glue, when the dressing is finished by a bandage put over the whole. The limb should be left at rest from twelve to twenty-four hours, when the bandage will be sufficiently hard to be cut through its whole length, and the margins trimmed with the scissors, so that an interval of a quarter of an inch will be left between them. Along the margins holes are now to be punched, and "oeillets" inserted into

them, through which a soft lacing cord is to be passed. In this apparatus the compression may be graduated by the cord; it is perfectly elastic, and may be removed from the leg with ease by simply pressing its sides asunder.

The metals used for metallic splints are iron, copper, lead, and zinc—particularly the former—under the forms of tinned sheets and wire-gauze. Of the tinned sheets, or, as it is more commonly called, tin, very light splints can be prepared by bending them into proper shape to fit the limb after having been cut roughly into the outline of the parts; to confer additional lightness they may also be perforated with holes. The proper shape is conferred upon wire-gauze by modelling it upon casts of the limbs in plaster of Paris or wood, and binding it with strong wire. The advantages claimed for splints made in this way are that they will permit the perspiration to escape freely, allow fluid applications to be made without impairing their stability; and lastly, are sufficiently flexible to be closely fitted to the parts beneath. But these advantages are more apparent than real; for the cotton-batting used with most all of this class of splints will serve as an effective absorbent, so that no more inconvenience will result from the exuded moisture in using them than those made of wire; wire-gauze cannot be so nicely adjusted to the limbs either as pasteboard and leather; and as to their permitting the employment of water-dressings, any other sort of splint will do the same without impairing its strength, if it is properly managed. There are exceptional cases, however, in which they may be used with advantage; for instance, in compound fracture of the elbow-joint, with profuse suppuration; and in gunshot wounds of this nature I have employed the wire splint with satisfaction. Bauer, of New York, has displayed a good deal of ingenuity in constructing this kind of apparatus, and it cannot be denied that they are gotten up very artistically; but their comparatively high cost, and inferiority to splints made of other materials, will prevent them from coming into general use.

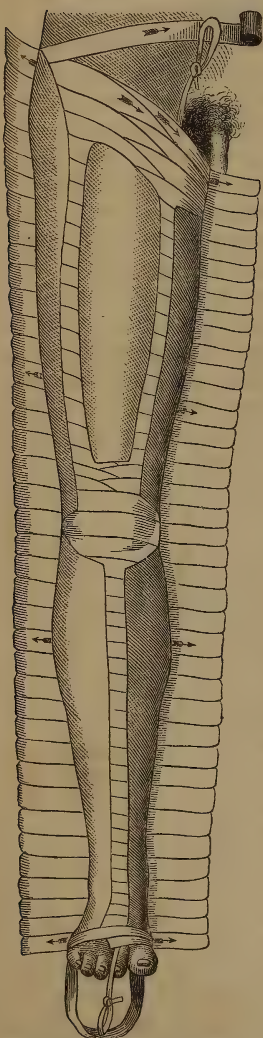
Immovable Apparatus.—The French surgeons have conferred this name upon a class of splints of which we shall now speak. They were undoubtedly employed long ago by the Arabs, and some of the Eastern nations, as the writings of Rhazes and Albucasis sufficiently prove. It is stated that the idea of treating fracture by the immovable apparatus, in modern times, first occurred to M. Geoffroy, suggested by an examination of some ancient Egyptian relics.

Theodoric, Lanfranc, and Guy de Chauliac, employed this form of bandage; and the latter recommended the use of a mixture of various gummy and resinous substances in its composition. Ambrose Paré directed his friend Richard Hubert, who was attending him for a fractured leg, "to fortify the sides of his limbs with junks made of tents or little sticks, and lined with linen cloth." He also gives the following formula for a mixture which "should be applied all around a broken leg;" frankincense, mastich, aloes, and Armenian bole, of each an ounce; alum and resin, of each three drachms; flour, a pound and a half; and a sufficient number of eggs to make a paste. In 1768 Moschati used compresses and bandages saturated with the

white of eggs; and Le Dran added to these, in preparing his bandages, vinegar, Armenian bole, starch, and plaster.

After Moschati, Baron Larrey was the first to revive the use of the *immovable* apparatus, and it was the authority of his name and practice which caused it to be generally adopted by surgeons everywhere. The solidifying liquid used by this distinguished surgeon was composed of camphorated brandy, Goulard's extract, and the whites of eggs beaten up with water. The dressing consisted of the bandage of Scultetus, two lateral splints made of unbroken straw, compresses, and a splint cloth.

Fig. 302.



Seutin's apparatus for fractures of the lower extremity.

This apparatus was used by Larrey, not only in fractures, but in severe contusions and wounds, and in the former case it was never removed until consolidation had taken place, unless some adverse accident compelled him to do so.

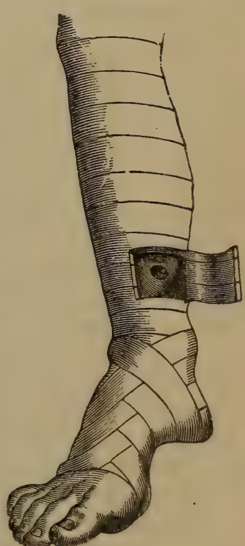
M. Seutin (*Traité de la Méthode amovo-inamovible,* Bruxelles, 1849), Surgeon-in-Chief of the Belgian army, began, in 1834, to make trials of various solidifying liquids, and of these found a solution of starch to be the best. He at first used a contrivance similar to that of Baron Larrey, but subsequently contrived a different one, which he designated as the "movable-immovable" apparatus (appareil amovo-inamovible); he adjusted its several parts in the following manner (Fig. 302): Having reduced the fracture, and made the surface of the limb uniform by compresses of amadou or tow, he applies a roller bandage from the toes upwards; reaching the superior portion of the member a reverse turn is made, and a second layer is put over the first from above downwards. A solution of starch is now smeared over the whole surface either with a brush or with the hand. Beneath the turns of the bandage along the anterior surface of the limb, and in contact with the skin, he places a greased cord called by him a *compressimetre* (compressimètre), the extremities of which hang externally and are looped; by pulling upon these loops the amount of pressure exercised by the bandage can be ascertained. Over the roller pasteboard splints are laid, having been previously softened in hot water, thoroughly starched upon both sides, and accurately modelled to the limb; while these are being held by an assistant he covers them with a roller bandage, proceeding from below upwards, and returning exhausts the roller

by several turns about the foot or ankle as the case may be, taking care always to have the toes and fingers exposed. An additional quantity of starch is again uniformly distributed over the apparatus with the palm of the hand, and the dressing is complete. In fractures of bones of the leg, M. Seutin employs, instead of the roller form of the bandage of Scultetus, interposing between the first and second a posterior pasteboard splint, and between the second and third bandages two lateral splints; all of these layers are to be starched, except the first. Seutin objects to placing a starch bandage in direct contact with the skin, as it is apt to produce irritation and possibly erysipelas.

While the bandage is desiccating, which occupies a period from thirty to forty hours, he advises precautionary splints to be applied to the sides of the limb to sustain it. When the drying is completed, Seutin directs the hardened shell to be cut open along its anterior surface, using the cord previously spoken of as a guide; the limb may now be inspected, and defects, if there are any in the dressing, corrected, such as the cording or knotting of the rollers; unequal pressure should be carefully guarded against by the use of compresses, or what is better, cotton-batting. If everything has gone on nicely, the valves should be drawn together and supported by the turns of a roller, or two or three elastic cords encircling the limb.

Should any wound exist, that portion of the pasteboard opposite to it may be removed with the scissors, having previously been softened with water; or, instead of removing the piece entirely, it will be better to let it remain as a sort of valve (Fig. 304), so that when the sore is dressed it may be again covered by the pasteboard, which will prevent any bulging out of the tissues beneath.

Fig. 303.



Immovable apparatus with valve over seat of injury.

Velpeau has also used extensively the immovable apparatus in the treatment of fractures. He employs a solution of dextrine instead of starch, made of the following articles: Dextrine, one hundred parts; camphorated brandy and hot water, of each fifty parts. The dextrine is placed in a vessel and the camphorated brandy is gradually added, stirring the while until the materials are intimately mixed and the solution is of the consistence of honey; the water is now poured in, which will render the mixture about as thin as a light soup when it is ready for use.

The fracture is first reduced, and the limb covered with a protective bandage, when the roller, soaked in the solution of dextrine, is laid on, beginning at the extremity of the limb and ascending in the usual manner, taking care to make the requisite number of reverses that the bandage may not pucker.

When the bandage formed in this manner is not sufficiently strong, Velpeau introduces, like Seutin, pasteboard splints among its folds, having previously softened

them in camphorated brandy, which will hasten the drying process, which requires about four or five hours. An opening may be left opposite any wound by leaving an interval between the turns of the rollers as they are being put on.

The quantities of dextrine used by M. Velpeau in preparing his bandages are as follows: For fracture of the thigh, eighteen ounces; for the leg, ten; and for the arm, seven. It is important to obtain a good quality of dextrine, as a good deal of that thrown into commerce is utterly worthless for the purpose of preparing bandages. The sort that should be selected is of a yellowish color and not so crumbly and crepitating between the fingers as those specimens containing starch; it strikes a deep red color with the tincture of iodine.

Splints of Plaster of Paris.—These were employed long ago by the Moors of Spain, and by Hubenthal in 1819; but their first introduction is commonly ascribed to Dieffenbach, of Berlin. The method was to surround the fractured portion of the limb with a large quantity of the plaster, so as to form a sort of box about it. Prepared in this way the splints were heavy and objectionable, inasmuch as they needed often to be cut away with hammer and chisel to expose the parts beneath rendered tender and painful by the confined perspiration and by the increased heat thereby produced; they are besides in constant danger of becoming constrictive to such a degree as to produce mortification, though I have seen several cases of fractured thigh brought to a happy issue, by the Dutch surgeons, with these splints.

These objections do not hold against the plaster bandages now to be described, which have been particularly studied by MM. Mathijssen and Van de Loo, of Holland, and Prof. Pirogoff, of St. Petersburg (*Gazette Hebdomadaire*, Aug. 1854). There are several methods of preparing them, but I have usually pursued the directions given by Van de Loo, who uses either rollers or the bandage of Scultetus. To make plastic splints of rollers, he recommends you to "spread upon a table a piece of cotton cloth, free from starch and softened by use, or of flannel, five feet long by a foot and a half wide; upon this cloth scatter at least a pound and a quarter of very dry plaster in powder, which should be made to penetrate it as much as possible by stroking it with the open palm; then, after having removed the excess of plaster, we turn the piece over, and perform the same operation upon the other side. Both sides of the cloth being well impregnated with plaster, we cut it, remaining still on the table, into strips one and a half or two inches wide, which can be neatly done by previously making grooves upon it, at equal distances, by means of a thin cord stretched across its surface, and which, raised with the fingers by its centre, is permitted to strike upon it; then we roll them upon the table with much less firmness than we do ordinary rollers. The roller bandages keep very well, providing we place them in a tight box.

"In order to use them, we take, if we have to do with a fracture of the leg, the member being previously surrounded with an ordinary roller bandage, one of these plastered rollers, which we moisten well with water, with the aid of a sponge (the water being introduced into both ends of the roller), and apply it as an ordinary roller, with

this difference, that the turns should cover each other three-fourths or four-fifths of their width; in the same manner we moisten and apply a second and a third roller, and so on, taking care to place the initial extremity of a succeeding one below that one applied just before. In this way the apparatus can be better unrolled.

"If we do not wish to make any reverses, we cut the roller each time that a change of direction becomes indispensable.

"In order to give the bandage the desirable smoothness and elegance, it suffices to pass lightly over its surface a slightly moistened sponge every time two or three rollers are applied.

"In order to make a fenestrum, we go to work in the following manner: Arriving near a wound, for example, we cut the roller and commence upon its opposite side, and continue thus until we have passed beyond the wound.

"Should we wish to render the bandage *removable* (amovible), we cut it by means of Seutin's scissors, and we obtain removable valves that answer special indications, which will be laid down further on.

"Should we wish to remove it, it is well to moisten it a little, to prevent the liberation of the dust of the plaster."

There are also two ways of making plaster splints with the bandage of Scultetus. "In the first, we arrange, in the form of the bandage of Scultetus, twenty-five or thirty plastered strips upon a cushion furnished with a napkin; they should cover each other three-fourths of their width. Upon these we place a layer of ordinary strips, and on this apparatus, thus prepared, we place the fractured member.

"After having applied the ordinary strips, we moisten, with the aid of a sponge, one or two plastered strips, which we apply immediately, and we continue thus until all the plastered strips shall be applied.

"In order to fenestrate the bandage, or to render it *removable*, we go to work as for the apparatus prepared with the rollers."

In the second method, "upon a cushion covered with a napkin we place first a plastered strip, over which we spread a strip without plaster, of the same width, but two fingers' width longer, in such a manner as to extend beyond the first a finger's width at each end, and with the same precaution to cause it to overlap also the plastered strip another finger's breadth in the direction of its width. The plastered strip which has the same dimensions in this direction as the strip without plaster will then offer a plastered border to unite with the other pieces of the apparatus. These first two strips being thus arranged, we spread a plastered strip upon one without plaster, in lengthening out the apparatus the width of a finger at each addition; upon this fresh strip another without plaster is placed, and so on successively until the whole bandage may be prepared.

"Then we put the member upon the apparatus, which is moistened with a sponge from which the water has been squeezed out, and one applies first a strip without plaster and one with plaster on the same side, and immediately we adjust in the same manner the opposite ends. We continue thus until the whole apparatus is laid on.

"In this manner there is always a strip without plaster between two strips with plaster, and *vice versâ*."

In preparing the bivalved apparatus, Van de Loo describes two methods. In the first "we cut six plastered strips from two and a half to three inches wide, and sufficiently long that they may extend from the superior part of the apparatus we propose to apply to three fingers' width below the soles of the feet, supposing, in the mean time, that we are operating upon the inferior member.

"Then we arrange upon a cushion, protected with a towel, twenty-five or thirty plastered strips, also from two and a half to three inches wide, of which the longest should be about ten and the shortest six inches for a man's leg. Upon these plastered strips we place simple strips (without plaster); next we lay the fractured limb upon the apparatus, and we apply the simple strips; then we take one of the six long strips which have been mentioned above, we moisten it well, and apply it upon the external side of the member from its superior part to below the sole of the foot; we place another of them in the same manner upon the internal side, leaving between the latter and the preceding an interval of one or two widths of the finger; this done, we moisten and apply the twenty-five or thirty strips with plaster upon them, which are arranged upon the towel; we finish the bandage by moistening and applying successively the four remaining long plastered strips—that is to say, two upon the external side and two upon the internal—taking care to cover the first two."

It is understood that in the case where the plastered strips which compose the apparatus of Scultetus should present a greater length than is necessary to apply them upon the margins of the valves, we should cut them as they are applied, that they may not encroach upon the space remaining free between the two halves of the bandage.

To render this apparatus *immovable*, we fill up the space remaining free between the two valves with a little tow, and we apply three or four plastered strips crosswise, or better one or two strips of suitable width in the direction of the width of the interval, concealing it completely. To establish the *removability* of the bandage, it will suffice to take away these strips.

If the apparatus is intended to envelop the whole of the inferior extremity, twenty more of these strips are necessary, of which the longest should be seventeen and the shortest eleven inches, as well as six long strips, extending from the knee to the superior part of the apparatus.

In the second method he directs that "we arrange two layers of strips without plaster, and superposed. We place upon the latter a piece of old blanket or flannel cut in proportion to the length of the leg, in a manner to embrace the posterior half or two-thirds of its circumference. This piece being previously impregnated with plaster upon its two faces, and upon that one which will be in contact with the limb, we arrange a layer of fine tow. The apparatus being thus prepared, we place the extremity upon it after having suitably moistened the plastered pieces, and we apply the whole by means of the superficial range of separate strips.

"The application of the first layer of strips being completed, we apply upon the anterior part of the leg a fresh layer of tow, or a

compress without wrinkles, and above this another piece of blanket or flannel equally impregnated with plaster, and suitably moistened, which covers the anterior of the leg and encroaches, the width of two fingers, on each side, upon the posterior shell. The whole is then fastened by the range of strips which have remained unapplied.

"Should we wish now to inspect the anterior part of the leg, we have only to detach the strips, and we can raise the piece of woollen cloth with the plaster on it, which protects this region, and afterwards reapply it, when we have examined the limb and finished the dressings required by the condition of the parts.

"Supposing that the section should be made at the external side of the leg, for example, in front or behind the fibula, the hinge (or junction) will consequently be found upon the internal side, and extend the whole length of the bandage. All being arranged and the limb placed upon the apparatus, we commence by applying the layer of simple strips, as that is ordinarily practised. We adjust subsequently the first three plastered strips which embrace the whole of the lower part of the leg. With the three following strips we behave differently in order to obtain at first a hinge, that is to say, a cloth connection which serves as a pivot to the valves and permits them to be opened without ever compromising the form of the plastered shells. At the moment when we apply them we should take the precaution to cut them in their passage upon the hinge. An interval of a fraction of a line is permitted between the two ends produced by this section, and we continue the application of these upon the rest of the circumference of the member. The two strips which then follow are placed entire, that is to say, without being cut, in such a manner that they shall perform, at a later period, the office of hinges. In short we continue thus the alternate application of these cut strips, and two entire strips, in such a way that after the section we obtain a hinged apparatus perfectly 'movable-immovable,' applying itself exactly to the whole limb, and not liable to be thrown out of shape in consequence of the different dressings or examinations that the condition of the limb demands.

"In order to render the plaster bandages perfectly 'movable,' it suffices to trace a groove in the plaster yet soft, immediately after the application of each apparatus, with the aid of the edge of a spatula, the back of a knife, or even with a small piece of coin. The groove thus traced suffices to constitute a joint which will permit the most extended movements to the valves that will be formed ulteriorly by the section of the bandage. For the inferior extremity we can, if we wish it, trace two lateral grooves in order to obtain two valves; whereas a single one will generally suffice for the superior extremity."

In using plaster with water alone the dressing has to be conducted with inconvenient haste, that it may not harden before all the pieces of the bandage are in their intended positions. The "setting" of the plaster may be delayed by mixing with the water which is added to it various foreign materials. Those most commonly employed for this purpose are starch, dextrine, and glue.

When starch is employed, its solution should be hot while the

plaster is being mixed with it; the proportion being equal quantities of the two materials, which must be incorporated little by little in an open dish. This mixture may be now used with the various forms of Van de Loo's bandages already described.

A solution of dextrine has the same effect as starch; it is used cold. The proportion of these articles may be varied to suit the emergencies of each case: to obtain, for instance, the consolidation of a bandage in fifteen or twenty minutes, we may employ a pound of the plaster to about a pint of water containing one ounce of dextrine in solution, the plaster being added in small quantities at a time to the solution, which should be stirred constantly during the preparation of the mixture.

I have been more in the habit of using glue in preparing plaster splints, and prefer it to any other article. The proportion will vary according as the consolidation is required to take place sooner or later. M. Richet, who employs these materials in making his bandages, says that fifteen grains of glue to a quart of water will not sensibly retard the setting of the plaster, but that twenty-one grains will delay it twenty or twenty-five minutes, seventy-seven grains from three to five hours, and one hundred and fifty-four grains from ten to twelve hours. He directs the solution to be used at a temperature of 68° or 77° Fahr., and that the plaster be incorporated with it until a paste is made, which may be applied either with the hand or a spatula. M. Richet prefers rollers made of tarlatan—a sort of a coarse gauze; in the absence of this, coarse muslin may be used. He always protects the parts beneath with a dry roller, and places his plastered rollers over this, and if the bandage is required to have more strength, as when an entire extremity has to be inclosed, the paste may be smeared upon its outer side with the hand, and subsequently rendered smooth with a spatula.

As a provisional dressing for fractures, and under circumstances where more efficient splints cannot be obtained, the apparatus of Scultetus will be found of real service. It consists of separate strips, straight splints, pads, and a splint-cloth. The strips may be from an inch and a half to two inches wide, and long enough to encircle the limb, and to overlap at each end three or four inches; these are imbricated from below upwards, each strip covering two-thirds of the width of its predecessor. The straight splints may be made of any material, such as wood, gutta-percha, pasteboard, or straw tied into little bundles by a cord wrapped spirally about them, but most commonly the first is employed. The pads are usually prepared of oat-chaff, though any soft material may be used, as cotton, flannel, lint, etc. The splint-cloth is made of muslin or other stout cloth, and should be sufficiently long to go around the circumference of the limb three or four times.

The apparatus is thus applied, for instance, in fracture of the thigh: Five strips of muslin, three for the thigh and two for the leg, are laid upon the mattress; upon these the splint-cloth is spread, bearing on its upper surface a sufficient number of imbricated strips to reach from the foot to the groin; the fracture is now to be reduced, and the limb

laid upon the strips, which are drawn over it from below upwards. Two lateral splints are now selected, the external one long enough to extend from the ilium to beyond the sole of the foot, and the internal one, from the perineum to the same point; and an anterior splint to reach from the fold of the groin to the dorsum of the foot. The lateral splints are rolled up in the splint-cloth from each of its ends towards the limb until but a narrow interval remains between them upon each side of the limb; two long pads are now introduced in these intervals between the limb and splints, while a third pad is placed beneath the long anterior splint, or the two short splints used by some surgeons. The splints arranged in this manner are to be held by assistants until the surgeon has secured them to the limb by the five strips of muslin above mentioned. The foot can be prevented from falling to either side by placing the middle portion of a strip of muslin upon its sole, crossing the ends upon its dorsum, and fastening them with pins to the lateral cushions.

The apparatus may be prepared in a similar way for fractures of the leg and arm, though, in the upper extremities, instead of the strips the roller bandage is most always used to make the compression.

CHAPTER II.

SECTION I.

FRACTURES OF THE BONES OF THE SKULL AND FACE.

FRACTURE OF THE SKULL.—Fractures of the bones of the skull are the result of exterior violence, and often involve the brain and its membranes in inflammation and suppuration. These complications require the most active medical treatment, depletion, application of cold, purgation, etc. When fragments of bone are driven into the substance of the brain, or the tables of the skull are beat in so as to press upon it, the case demands certain surgical procedures, the application of the trephine, &c., which are more properly described in general works on surgery.

The mastoid process of the occipital bone has been rarely broken off by direct violence, and displaced downwards by the contraction of the sterno-cleido-mastoid muscle.

Treatment.—Incline the patient's head to the injured side, and retain it in the position either by the figure of 8 bandage of the head and axilla, or the double T of the forehead and chest.

By the same sort of violence the external angular process of the frontal bone may be broken and displaced inwards towards the eye, or backwards towards the temporal fossa; along with this injury there is always found fracture of the malar bone and zygomatic arch.

In the treatment of such a case replace the fragment by pressure

with the fingers, or by means of a lever, if there be a wound. There is no tendency to displacement by muscular action, so that a pledget of lint dipped in cold water and laid upon the part will be the only dressing required.

If the injury is confined to the frontal bone, there will be no further trouble; not so, however, if the eye is damaged, or, as is more often the case, the brain, by the same blow. The case is decidedly more serious, and requires a very guarded prognosis. These complications are to be met by active antiphlogistic measures.

Fracture of the Nasal Bones and Cartilages. *Causes.*—The cause of fracture of the nasal bones is direct violence, such as is inflicted by blows with the fist, falls, and by gunshot wounds. The fracture may be simple or comminuted; pass transversely through the lower third or middle of the bones, or vertically in a line with their length; and sometimes the separation occurs at their junction with the nasal process of the superior maxillary. Rarely a single nasal bone is broken. In these cases there will be more or less displacement, and sometimes fracture of the septum of the nose, though the latter occasionally happens even when the force is not sufficient to break the nasal bones; the fracture takes place generally at the junction of the cartilage with the bony septum, or in the vertical nasal plate. The cartilaginous portion of the bridge of the nose may also be bent in or broken.

The displacement occurs backward or laterally, according to the direction of the force brought against the nose.

Symptoms.—There is almost immediately great swelling of the nose, with more or less bleeding from it; the deformity is marked, and the fragments may be moved with the fingers, or with a thin metallic instrument, as probe or director, introduced into the nostrils. As the Schneiderian membrane is sometimes ruptured, the air is driven, during expiration, into the cellular tissue of the eyelids and the adjacent parts, producing emphysema.

When the force causing the fracture is very violent, the brain and its membranes may be involved in inflammation and suppuration by the fracture running through the ethmoid, sphenoid, or frontal bones. In these complications, to the above symptoms there may be added those of concussion, and, in the worst cases, coma.

Diagnosis.—Should the case be seen early, and a careful examination had, there can be little difficulty encountered in making out the exact condition of the nasal bones; at a later period the diagnosis is exceedingly difficult, so that in a large number of cases of this injury, from the great swelling which ensues, the displacement of the fragments passes unrecognized either by the physician or by the patient. It is not until the tumefaction has disappeared that the marked deformity resulting from even a trifling displacement of the fragments becomes apparent, and induces the patient to seek aid of the surgeon at a period when but little can be accomplished.

Prognosis.—There is no danger to be feared in a case of simple fracture of the nasal bones, though when the ethmoid and frontal are involved in the fracture, as they sometimes are, and the brain

damaged, death will usually result from the injury, and hence the prognosis should always be guarded when these complications are suspected or are discovered to exist.

The frequency of deformity following this injury should admonish us not to commit ourselves by any assurances as to the ultimate result of the case in this particular.

Occasionally, also, catarrh and obstruction of the nostrils will be established and last for months; in other cases, obliteration of the nasal duct, giving rise to fistula, epiphora, &c., has been noted; and, rarely, an obstinate ulceration of the nasal mucous membrane and cartilages.

Treatment.—In the treatment of this fracture our first object will be to make a thorough examination of the nose, and as this is exceedingly painful, the patient may be put under the influence of chloroform, if it is necessary, to accomplish this purpose.

The reduction of the fragments may be effected with a thin steel-grooved director or probe, passed into the nares, and pressed against the bones from behind forwards, while, with the fingers placed upon the outside of the nose, counter-pressure is made. In this manner we must endeavor to restore the natural outlines of the organ.

When the replacement has been effected, as there are no muscular fibres acting upon the fragments, they generally retain their position without any bandaging whatever, though it must not be forgotten that when the bones are broken into a number of fragments, sneezing or hawking may displace them, and the patient should therefore be cautioned to abstain from these actions as much as possible.

Should the nose incline to either side, a narrow compress should be laid upon each side of the organ after it has been restored to its natural position, and secured in place with the double T bandage of the nose, avoiding making any backward pressure. No plugging the nostrils with lint should be had recourse to, as it can do no good; and this will be evident if anatomical structure of the upper and anterior portion of the nares is considered. The space where pressure could be of any service is exceedingly narrow, and it is very questionable whether, with the swelling of the mucous membrane, it could be packed with lint. The same objections hold against the use of apparatus having levers connected with them, and intended to be introduced into the nostrils to support the bones.

Consolidation takes place rapidly, and after the lapse of seven or eight days the fragments may become immovable.

The only dressing required will be a light cloth, wrung out of cold water, laid over the nose.

The excessive hemorrhage may require the nostrils to be tamponed, an operation which will be described further on.

If the septum of the nose is deviated to either side, we should endeavor to press it into its natural position with the point of some blunt instrument; and if any tendency exists to a recurrence of the displacement, the nostrils should be equally padded with pellets of lint.

Some authors recommend the use of a splint of the exact shape of the nose, and moulded to its outside. Dr. Hamilton, in a case in which

the bridge of the nose was depressed at the junction of the osseous with the cartilaginous portion, and the tip tilted forwards, restored it to its natural shape, one year after the accident, by loosening the depressed cartilage with a point of a bistoury, and, having passed a ligature through it, raised it to its proper level, where it was retained by tying the ligature over a gutta-percha splint accurately fitted to the nose; the ligature was removed in two days, but the splint kept on two weeks.

Fracture of the Superior Maxillary Bone.—Fracture of the superior maxillary bone may occur in its body or in its processes. As has already been stated, in the preceding article, its nasal process is sometimes broken at the same time that the nasal bones are crushed in. The alveolar process is sometimes damaged by violent efforts at extracting teeth, and Le Dran records a case in which a man had that portion of the alveolus containing the last four molar teeth broken off and lodged beneath the roof of the mouth, by a cart-wheel passing over his head; the palate and gums remained entire.

In other instances the violence is so great as to fracture the body of the bone and its palatal process; and lastly, in gunshot wounds, both superior maxillaries may be destroyed. Ribes relates a remarkable case (*Dictionnaire des Sciences Médicales*, tom. xix., art. Machoire), in which a soldier, at the siege of Alexandria, in Egypt (1801), was wounded by a shell, which carried away the right malar bone, both upper maxillaries, the greater portion of the lower jaw, the nasal bones, cartilages, and septum, the vomer, and a portion of the ethmoid bone.

Causes.—From the firm manner in which the superior maxillaries are wedged in among the other bones of the face, it requires great and direct violence to break them; though Richerand and J. Cloquet each record a case in which the injury resulted from counter-stroke; in the first the chin and head were acted upon by two opposite forces, and in the other a violent blow was inflicted upon the chin from below upwards. These fractures are also accompanied with more or less contusion and laceration of the soft parts, and sometimes with cerebral disturbance.

Symptoms.—The mobility of the fragments, when pressed with the fingers, the irregularity of the dental arch, if the fracture pass through it, and the apparent deformity, will generally declare the nature of the case. Extravasation of blood into the orbit will sometimes render the eyeball more prominent.

Prognosis.—From the amount of injury necessary to cause a fracture of the upper jaw, particularly of its body, we should be exceedingly circumspect in delivering a prognosis, and especially when there is reason to suspect that either the brain or the ethmoid or sphenoid bones have been also implicated in the injury. An uncomplicated fracture will heal rapidly and safely, and in some cases it is astonishing how soon the consolidation occurs even when the fragments are loosely connected with soft parts.

When the malar bone is driven in upon the antrum, some deformity will remain if it is not raised, and also a displacement of a portion of

the orbital process of the superior maxillary will result in the same manner and force the ball of the eye forwards.

Should cerebral symptoms, as coma, delirium, &c., set in, we may infer that the fracture has extended to the bones at the base of the skull, which will render hopes of recovery very slender indeed.

Treatment.—In a fracture of the nasal process of the superior maxillary, which, as already stated, occurs usually with a similar injury of the nasal bones, the treatment should be conducted in the same manner as for it; that is, the reduction must be attempted with a slender steel instrument introduced into the nostrils, while pressure is made with the fingers upon the outside of the nose.

When a portion of the alveolar process is broken, it should be restored to its natural position, and retained there by the simple expedient of closing the lower teeth upon the upper, and applying a sling bandage for the lower jaw. If this plan is not successful, any flexible and strong wire, such as iron or silver, may be used to tie the loosened teeth to the firm ones. To put the wire in place, pass its two ends between the teeth, and twist them together with the fingers, or, what is better, with a pair of long pointed pliers; thread or silk may be also employed for the same purpose as the wire.

In some cases a gutta-percha splint, moulded to the palatine vault and the teeth, will answer admirably in supporting the broken fragment.

One of the superior maxillaries may be so loosened from its connections with its fellow and the other bones with which it articulates, that it becomes displaced to a considerable extent; the palatine processes are separated from each other or override. In this case, when the reduction has been accomplished by pressure with the fingers in the mouth and a female catheter introduced in the nostril, the gutta-percha splint above mentioned may be applied, and the jaws held immovable by a sling bandage. A heavy blow struck upon the malar bone may break the anterior wall of the antrum and depress the cheek; this injury is commonly attended with a fracture of the alveolar process. In this case an effort should be made to raise the malar bone with the finger, introduced into the mouth between the gum and cheek, behind the zygomatic process.

If there is a wound upon the face, a lever may be used with the same object; though rather than permit the bone to remain depressed a small incision should be made in front of the masseter through which the lever may be introduced beneath the malar bone.

If the floor of the antrum is broken away, the point of the finger may possibly be put into that cavity and pressure brought to bear upon the posterior surface of the displaced bone. It has also been recommended to extract one of the molars so that a steel instrument might be thrust into the antrum; but in extensive fracture of the upper maxillaries this plucking out of the teeth is not unattended with danger, and it would be much more preferable, in order to gain admission into the antrum, to perforate its anterior wall and use a curved lever.

The removal of loosened fragments of the upper jaw should be

delayed as long as possible, for the reason that union does occur sometimes under the most unfavorable circumstances.

The fractures resulting from gunshot are to be treated upon the general principles already laid down, and although large portions of the upper jaw may be carried away and frightful deformity succeed, yet, after the lapse of some months, the recuperative efforts of nature do a great deal in remodelling the lacerated parts that they may be better able to perform their functions. When this is accomplished, the patient's condition may be made much more comfortable by the use of appropriate prosthetic apparatus.

Fracture of the Malar Bone. *Causes.*—As in the case of the other bones of the face, fracture of the malar bone implies the application of great direct force to the part, as the kick of a horse, and is almost always accompanied with a fracture of the superior maxillary. A blow upon its orbital border may result in a fissure of this bone alone. In a few cases observed the bone, instead of being fractured, seems to have been simply displaced; its orbital margin, being tilted forwards and pressing upon the eyeball, interferes with its movements.

Diagnosis.—The depression of the cheek and mobility of the fragments when manipulated with the fingers will sufficiently establish the nature of the case.

Prognosis.—Fracture of the malar bone without cerebral complications will generally heal speedily, and, at the worst, only leave some deformity; while, on the other hand, disturbance on the part of the brain indicates associated damage to the neighboring bones, and renders the patient's recovery extremely doubtful.

Treatment.—If there is a displacement of the fragments of the malar bone, they should be restored to their natural position in the manner already pointed out in the previous article. After the reduction is accomplished, water-dressings may be applied. Cerebral complications must be met by appropriate treatment, according to their nature.

Fracture of the Zygoma.—The zygomatic arch, formed by the zygomatic processes of the malar and temporal bones, although very slender, is yet rarely broken.

Causes.—The causes are blows upon the malar bone, and violence acting directly upon the arch either from within or from without. Two cases are reported in which the injury resulted from force applied in the former manner, by a pointed instrument thrust into the mouth passing out at the temple and striking the arch.

From the attachment of strong ligamentous and muscular fibres to the borders of the zygoma, it can well be understood that there can be but two directions in which displacement may occur, namely, inwards and outwards, according as the force acts from within or from without.

Symptoms.—The naturally curved outline of the zygoma can readily be felt with the fingers, so that when a case of fracture is seen early; any salient or re-entrant angle formed by the fragments of the broken bone in the temple can be readily felt; they may also be moved so as to develop crepitus. Should any sharp point of bone have

penetrated the masseter muscle, there will be difficulty in moving the lower jaw, and in some instances this is entirely impracticable.

Prognosis.—A simple fracture of the zygoma is of little moment, and in all the recorded examples union has taken place promptly. Stiffness of the lower jaw will gradually pass away.

If the violence has been very severe and the case is complicated with fracture of the facial bones, and cerebral disturbance, the danger will, of course, be in proportion to the extent of these complications.

Treatment.—If the fragments of the broken zygoma form a salient angle in the temple, it may be depressed to the natural level by pressing upon it with the ball of the thumb. In an inward displacement, on the contrary, the depressed bone should be raised by pressing with the finger upon the inside of the cheek—a practicable procedure when the fracture is near the malar bone. If there is a wound, an elevator may be introduced beneath the zygoma and its elevation easily accomplished; if the skin is intact, a small incision may be made, as was done in two of the recorded cases, to admit the point of the instrument.

No apparatus is required after the reduction is effected, as the fragments will retain their position.

Fracture of the Inferior Maxillary Bone.—Although the inferior maxillary bone forms so prominent a part of the lower portion of the face, yet it is not frequently fractured. This is due, in a great measure, to its mobility and arched form.

Causes.—In a majority of instances the fracture results from direct violence, as the kick of a horse, or a blow with a club, or the fist; it has also resulted from counter-stroke, as when a blow struck upon the side of the jaw breaks the neck of the condyle upon the opposite side; the neck may also be fractured by a blow upon the chin. A third example of this injury from counter-stroke is where the angles of the inferior maxillary are pressed together when the fracture will occur at the symphysis. Portions of the alveolar process are sometimes broken off by unskilful dental operations. Muscular action has also been recorded as an occasional cause.

The bone may be fractured in its body, angles, ascending rami, necks of the condyles, or in the coronoid process (Fig. 304).

Fig. 304.

Specimen showing three forms of fracture of the lower jaw.

When the body of the bone suffers the line of fracture will, in a majority of cases, be found at or near the mental foramen. Boyer denies that it even occurs at the symphysis, yet accurate observers have met with such cases; after the naval engagement at New Orleans one was admitted into the hospital under my charge. The fracture resulted from a glancing shot which carried away the lower lip, and thus enabled me to get ocular demonstration of the position of the injury. The patient was aged twenty

years; the fissure was seated exactly vertical between the two middle incisors, which, though loose, were not dislodged from their alveoli. The young man made a speedy recovery, and I restored the lip by a plastic operation.

As to the direction of the line of fracture in the body of the bone, it may be vertical, oblique, or horizontal; generally it is backwards and inwards, so that the posterior fragment will ride over the anterior, the latter (if there is a fracture upon both sides) being drawn downwards and a little backwards by the digastricus, genio-hyoid, and genio-hyo-glossus muscles.

If the fracture is seated at the angles, the insertions of the masseter and internal pterygoid muscles will hold the fragments together so that there will be little displacement.

One or both necks of the condyles may suffer at the time of the infliction of the injury; the external pterygoid muscle will draw the condyle upwards and inwards, while the masseter acting upon the angle of the jaw will displace the lower fragment forwards and upwards, throwing the mouth open a little thereby; if the fracture is upon one side only, the chin will be turned a little to the sound side.

When the line of fracture passes through the coronoid process the only displacement that occurs is by the temporal muscle pulling that process upwards.

Symptoms.—Besides the displacements above described, the other symptoms of fracture of the lower jaw are mobility of the fragments, which can in nearly every case be developed by manipulation; slight depression in front of the external meatus, if the injury is seated at the neck of the condyle, resulting from the upper fragment being drawn forwards and inwards; crepitus, which may be felt when the jaw is moved, and pain at the point of injury. A fracture of the coronoid process can be ascertained by introducing the finger in the mouth and feeling the anterior edge of that process behind the last molar tooth when any existing mobility or crepitus would be perceived.

The presence of any irregularity of the dental arch, loosening of the teeth, or laceration of the gums, will also furnish important information as regards the existence and seat of a fracture.

Prognosis.—Fractures of the alveolar process usually result favorably; the bone unites, and the teeth, if they have been loosened, become firmly fixed. The same satisfactory issue will usually be obtained in single fracture of the body, symphysis, and angles of the bone. When the fracture affects both sides of the jaw, or the necks of the condyles, some little deformity or irregularity of the dental arch will often result in spite of the best-conducted treatment. The prognosis in compound and comminuted fracture is still less favorable, implying the infliction of greater force upon the face, and rendering escape from some degree of deformity much less probable. Abscess sometimes occurs in these cases, giving rise to tedious and troublesome exfoliations.

In rare cases, paralysis of the muscles of the lower lip and convulsions have resulted from the injury.

In making the prognosis it should also be remembered that a heavy

blow struck upon the chin may produce serious injury to the bones at the base of the skull, hemorrhage from the auditory meatus, hardness of hearing, and buzzing in the ears.

Delayed union has been observed in some cases; according to Sanson union of the coracoid process with the ramus never takes place by bone.

Treatment.—The reduction of a fracture of the body of the inferior maxilla, either single or double, is very easily accomplished by seizing the anterior fragment and raising it upwards and forwards until it is exactly level with the posterior one, which retains its natural position; the adjustment is known to be perfect when the inferior border of the bone forms a regular and unbroken line. In fracture of one or both condyles with displacement of the fragments the reduction is not so easy; for it will be necessary at the same time that the jaw is being drawn forward, to make pressure upon the condyle with the tip of the finger introduced into the mouth, so as to force it outwards, when it may be clamped between the lower fragment and the glenoid cavity by simply pressing the chin backwards and upwards.

To maintain the fragments in their natural position various contrivances have been suggested and employed from an early date. One of the first was the ligature, which is to be applied around the necks of the teeth upon opposite sides of the line of fracture, and tied tightly. The materials of which the ligature is made may be any strong thread, or silver, gold, or platinum wire.

Baudens, in a case of very oblique fracture complicated with a wound, bound the fragments together by means of a ligature passed around them in the following manner: he took a long needle flexible at its middle, and perforated with two eyes, armed with a ligature formed by twisting six or eight threads together; the fracture having been reduced, while the fragments were steadied with the thumb and index finger of the left hand, he introduced the point of the needle at the lower margin of the inferior maxilla and carried it along its inner surface beneath the gum to the roots of the tooth, where the ligature was pulled into the mouth from the nearest eye; the needle was now withdrawn to the lower edge of the jaw and passed between its outer side and the gum into the mouth again, where the ligature was removed from the second eye; thus the jaw was inclosed in a loop, to be secured over the teeth or a splint moulded to them. Baudens stated that the case did well, and the ligature was removed on the twenty-fourth day.

In two or three recorded cases the ends of a broken jaw have been perforated, and held together by a metallic suture.

We have already described the sling and crossed bandages for the jaw, sometimes employed in the treatment of fracture of this bone. As an improvement upon these, Dr. J. R. Barton, of Philadelphia, recommended a bandage (Fig. 305), which he applied in the following manner: "A roller, an inch and a half wide, is placed just below the prominence of the os occipitis; and he continues it obliquely over the centre of the parietal bone across the juncture of the coronal and sagittal sutures, over the zygomatic arch, under the chin; and pursuing the same

Fig. 305.

Barton's bandage for a fractured jaw.

direction on the opposite side until he arrives at the back of the head; he then passes it obliquely around and parallel to the base of the lower jaw over the chin; and continues the same course on the other side until it ends where he commenced, and repeats."

Prof. Gibson describes a bandage (Fig. 306) for the same purpose (*Surgery*, vol. i. 246). He says that after the jaw has been modelled into proper shape, and the mouth firmly closed, "then a cotton or linen compress of moderate thickness, reaching from the angle of the jaw nearly to the chin, is placed beneath and held by an assistant, while the surgeon takes a roller, four or five yards long, an inch and a half wide, and passes it by several successive turns under the jaw, up along the sides of the face and over the head; now changing the course of the bandage, he causes it to pass off at a right angle from the perpendicular cast, and to encircle the temple, occiput, and forehead horizontally by several turns; finally, to render the whole more secure, several additional horizontal turns are made around the back of the neck, under the ear, along the base of the jaw, over the point of the chin. To prevent the roller from slipping or changing its position, a short piece may be secured by a pin to the horizontal turn, taking care to fix one or more pins at every point at which the roller has crossed."

Fig. 306.

Gibson's bandage for a fractured jaw.

It should be borne in mind that, in using any of the above-described bandages in fracture of the necks of the condyles, the horizontal turns around the chin and occiput have a tendency to throw the lower fragment upwards and backwards, a position just the reverse of that it ought to occupy.

To secure greater firmness in the bandage, and to render it less liable to slip, the chin should be shaved, the hair cut short, and a muslin cap fitted to the head, to which the turns of the roller may be pinned. The same objects may also be obtained by smearing the bandage with solutions of dextrine, starch, plaster of Paris, or other consolidating material.

In connection with these bandages it will be advantageous to employ a cap of softened pasteboard, sole-leather, or gutta-percha accurately moulded to the under and lateral parts of the lower jaw.

Two broad strips of adhesive plaster, one encircling the top of the

head and under surface of the chin, and the other passing around the chin and occiput, will also make a good jaw-sling.

Dr. Hamilton (*A Practical Treatise on Fractures and Dislocations*, p. 135) says that, having frequently noticed the tendency of the sling, as ordinarily constructed, and of Gibson's roller, to carry the anterior fragment backwards, he devised, several years since, an apparatus intended to obviate this objection. "It is composed (Fig. 307) of a firm leather strap, called maxillary, which, passing perpendicularly upwards from under the chin, is made to buckle upon the top of the head, at a point near the situation of the anterior fontanelle. This strap is supported by two counter straps, called, respectively, occipital and frontal; made of strong linen webbing. One of these, the occipital, is attached to the posterior margin of the maxillary strap, about half an inch above the ear, and being carried around behind and under the occiput, it is finally buckled to the maxillary strap about half an inch above the ear; and being carried around behind and under the occiput, it is finally buckled to the maxillary strap upon the opposite side, and at a point exactly corresponding to its origin. The frontal stay simply antagonizes the occipital, and having its origin and termination at the anterior margins of the maxillary strap, it is buckled horizontally across the forehead, and just above the eyebrows."

Fig. 307.

Hamilton's apparatus for a fractured jaw.

"The maxillary strap is narrow under the chin, to avoid pressure upon the front of the neck, but immediately becomes wider, so as to cover the sides of the inferior maxilla and face; after which it gradually diminishes to accommodate the buckle upon the top of the head. The anterior margin of this band, at the point corresponding to the symphysis menti, and for about two inches on each side, is supplied with thread-holes, for the purpose of attaching a piece of linen, which, when the apparatus is in place, shall cross in front of the chin, and prevent the maxillary strap from sliding backwards against the front of the neck."

We shall now consider a class of apparatus which contains contrivances that have been recommended by many eminent and ingenious surgeons. The principle upon which they are all based is nearly the same, namely, clamping the fragments of the jaw between two parallel forces acting in opposite directions. Desault seems to have carried the idea into practical effect in 1780. He employed a submental splint of sheet-iron, or some other material, to which were attached sliding-hooks, armed with pieces of cork or plates of lead, to

catch upon the crowns of the teeth. Since that time surgeons have made a great many improvements upon his clumsy apparatus, and achieved much success in the treatment of fractured jaw.

Baron Boyer (*Traité des Maladies Chirurgicales,* vol. iii. p. 131) recommends that when the fracture is oblique and double, in order to prevent deformity of the jaw, a cork splint grooved in the form of a gutter upon both its faces, to accommodate the teeth, should be placed between the dental arches, and the jaws held together by a sling bandage.

Dr. Mütter, of Philadelphia, substituted for the cork splint a clamp of silver, as more cleanly, and not as liable to be broken as the cork is; others, still, have made the splint of ivory and certain kinds of wood.

Gutta-percha is, perhaps, one of the best materials of which to make inter-dental splints; it adapts itself evenly to the jaws and teeth, does not decay, and with proper care does not become fetid by the secretions of the mouth. It may be used in the following manner; take two pieces of the gutta-percha of the proper size, soften them in water, and place one of them upon each side of the jaws, which being pressed together imbed the gums and teeth into the material. After a few minutes the gutta-percha hardens and forms an exact mould of the parts, when the two lateral splints may be removed, and properly trimmed to remove rough points, or irregular edges; they are then put in place again, and the jaws held together by the four-tailed bandage of the chin.

Malgaigne (*Traité des Fractures,* tom. i. p. 395) describes an apparatus consisting of a narrow and thin lamina of flexible steel, capable of adapting itself to all the irregularities of the posterior dental arch; from its two extremities, and two intervening points, equally distant from them, four little metallic pins arise to the level of the crowns of the teeth, which they cross, and are then bent so as to run parallel with their anterior surfaces; the extremities of the pins are furnished with four little thumb-screws to clamp the plate against the back of the teeth. To prevent the screws damaging the enamel a plate of lead is interposed between them.

In another class of contrivances a submental splint is introduced to which the dental splint is attached.

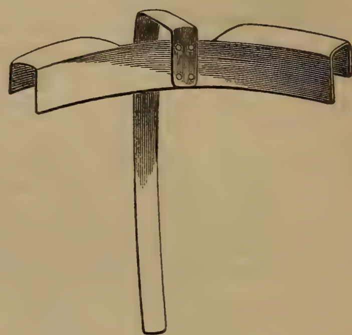
One of the first instruments of this kind is that of Rutenick, invented in 1799. It has since been modified by Bush, Hartig, Lonsdale, Houzelot, and Jousset (see *Atlas* of F. J. Behrend, Pl. 7, Figs. 18, 19, 20, 22).

Several years ago I contrived an apparatus (Fig. 308) which was used successfully in twelve cases of fractured jaw, more than half of which were compound, and resulted from gunshot. I made a model of the lower jaw with softened pasteboard, and then spread this out on block tin, which was marked, cut into shape, and modelled so as to fit the inferior maxilla exactly, with two arms extending up in front of the ears. The horizontal part was so rounded as to fit the lower edge of the bone for its whole extent, and projected upwards towards the alveolar process about half an inch, and backwards beneath the chin an inch and a quarter—this edge being circular, and fitting the neck

above the hyoid bone. The splint is then covered with buckskin, and padded here and there, as pressure is necessary, at this or that point. Three straps (1, 2, 3) are attached to the apex of the arms of the splint

Fig. 308.

Fig. 309.



The author's apparatus for fractured jaw.

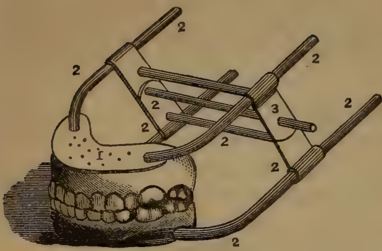
and buckle over the head—all being secured in the median line by a strap (4). Another strap (5) passes through a bracket, soldered under the body of the apparatus, and buckles over the head.

To the anterior part of the apparatus a slat is soldered, through which passes a perpendicular bar of stiff and flattened wire bent opposite the mouth at a right angle, and projecting into it. To the point of the wire a dental splint is attached, which is made of tin, and fitting the teeth clasps them on either side, leaving an interval between its lateral limbs, as seen in Fig. 309. This, the *dental splint,* is movable along with the perpendicular bar, which slides through the chin-slat, and can be secured by the thumb-screw.

I now make both the dental and submental splints of gutta-percha, instead of tin. The advantages of this apparatus are that the sub-dental splint forms an exact model of the natural configuration of the jaw, in which the fragments of the broken bone repose in a natural position, and shielded from all lateral pressure from bandages, which is often a cause of displacement; by means of the straps the jaw may be pressed in any desired direction, and held immovable until consolidation occurs; and lastly, the dental splint prevents the fragments overriding, and separates the jaws sufficiently far to enable the patient to take fluid aliments.

Dr. Beans, a dentist of Atlanta, Ga., has treated over forty cases of fractured jaw, with great success, with an interdental splint of vulca-

Fig. 310.



Maxillary articulator. 1, 1. Upper and lower plates. 2, 2. Adjustable rods. 3, 3. Adjustable hinge.

nite, which is prepared in the following manner: Take impressions of the teeth of the upper and lower jaws—those of the latter in each fragment separately—in wax, in the ordinary manner of dentists. Upon these make plaster of Paris casts, which are to be placed in the position that the jaws would naturally occupy closed, and held in a metallic frame called a "maxillary articulator" (Fig. 310).

The casts are now separated from three to five lines, and a wax splint built up between them, leaving an interval in front through which aliment may be introduced.

Prepared in this way, the model jaws are removed from the "articulator," and a cast made of them in plaster of Paris, from which the wax is now to be removed, and the space left by it filled with India-rubber softened with heat; the mould is then placed in a dentist's "flask," and heat applied until the rubber is thoroughly vulcanized. The splint is now finished, and is to be removed from the flask.

Fig. 311.

Bean's apparatus for fractured jaw.

The splint is applied to the teeth, which it fits very accurately, and the jaws are closed by a submental splint formed of a transverse piece of wood, provided with a cup at its centre to receive the chin, and supported by the straps in the way seen in Fig. 311.

For the first three or four weeks of treatment, a patient with a fractured jaw should take nothing but fluid aliments, and after the removal of the apparatus it will be advisable for him to use soft food for a few days, in order not to jeopardize the safety of the osseous union by mastication. The mouth should be frequently cleansed with tincture of myrrh or a mixture of Labarraque's solution in water.

SECTION II.

FRACTURES OF THE BONES OF THE TRUNK.

Fracture of the Hyoid Bone.—The hyoid bone, from its mobility, and protected situation beneath the chin, is rarely ever fractured.

Causes.—The causes of the injury are blows upon the front of the neck in falling against some hard object; and pressure with the fingers in grasping the throat, or from a ligature. A case is reported where

the accident resulted from muscular action, the head having been violently thrown backwards. It has been most frequently observed in aged persons. The fracture may affect the body or one or both cornua of the hyoid.

Symptoms.—At the time of the infliction of the injury the patient experiences a sensation as if something had been crushed at the upper part of the neck, in which part and the jaw severe pain is felt, aggravated by the least motion of the head or mouth; articulation and deglutition are often impossible, or performed with the greatest difficulty; the tongue cannot be protruded from the mouth; and there will be tumefaction and contusion, often accompanied with ecchymosis of the front of the throat.

If there is any displacement of the fragments, it will occur inwards, producing some irregularity in the contour of the hyoid; crepitus may generally be developed, either by manipulating with the fingers or by efforts of deglutition. Other symptoms have also been recorded as sometimes accompanying this injury, such as hemorrhage from the pharynx, in consequence of the wounding of its mucous membrane by a spicula of bone; suffocation, cough, and expectoration.

Prognosis.—Simple fracture of the hyoid will commonly unite in from six to eight weeks; should the case, however, become complicated with severe inflammation, abscess, or necrosis of the bone, from the violence of the injury or the laceration of the neighboring soft parts, the life of the patient will be seriously compromised.

Treatment.—If there is displacement of the fragments, reduction should be at once attempted by pressing them outwards with the point of the finger introduced into the pharynx. There is no tendency of the fragments to slip away from each other after they have been brought into their normal relations, so that position of the head alone suffices to maintain the reduction. This should be one of moderate extension, to establish a uniform traction of the muscles inserted in the hyoid bone above and below. Excessive inflammation must be controlled by local depletion and saturnine and anodyne applications.

Should the patient not be able to swallow, aliment may be introduced into the stomach with a long flexible tube; but it will always be better to deny the patient everything for the first three or four days except what is absolutely required.

Abscess in the neck should be opened at once, and the first opportunity sought to remove any portion of the bone that may have become necrosed. Should suffocation threaten, tracheotomy will, of course, be demanded.

Fracture of the Laryngeal Cartilages.—The thyroid and cricoid cartilages may be fractured either separately or together. As to the character of the fracture, it may be simple, comminuted, or compound.

Causes.—The causes of the injury are direct violence inflicted upon the part, as grasping the throat forcibly between the fingers, falls upon some hard projecting ridge, kicks of a horse, and gunshot. During the late war I saw three cases of fractured thyroid cartilage from the last-mentioned cause, two of whom died, and autopsy revealed the nature of the injury; the third recovered.

Symptoms.—The only certain symptoms of this injury are crepitus, mobility of the fragments, and deformity of the larynx; other phenomena are, however, in most cases present—difficult respiration, whispering voice, or the voice may be entirely lost, deglutition painful or impossible, cough, hemorrhage from the larynx, and emphysema of the neck.

Prognosis.—Fracture of the laryngeal cartilages, even when simple, is a serious matter; and if the violence inflicting it is severe, or if there should be displacement of the fragments, or complications of any sort, such as severe inflammation, &c., the patient almost always loses his life.

Treatment.—The object of the practitioner should be to combat local inflammation, by leeching and other suitable antiphlogistics. When the respiration begins to be labored, tracheotomy or laryngotomy must be had recourse to at once; it will be fatal to the welfare of the patient to delay the operation too long. If the larynx is comminuted, and the fragments displaced, the safest plan will be to perform laryngotomy, and restore them to their natural situation.

FRACTURE OF THE VERTEBRÆ.—From the firm interlocking of the vertebræ, which are bound together by strong ligaments and covered by powerful muscles, great violence is required to be inflicted in order to fracture them. The fracture may affect the body, laminæ, spinous or transverse processes. Its direction in the body of the vertebræ may be vertical or oblique, and in the latter case it usually runs downwards and forwards, causing the upper fragment to slip in a corresponding direction.

In the recorded cases of this injury affecting the laminæ, the line of fracture has occurred nearly vertical, and upon both sides.

The transverse processes are rarely ever broken, and then always by a gunshot or penetrating wound which inflicts grave injury upon the surrounding tissues and organs.

Causes.—The causes are blows upon the line of the spine, falling upon the back against some hard and projecting object, alighting upon the head, or buttocks, or even upon the feet after being precipitated from a height; and gunshot wounds.

Symptoms.—The symptoms of fractured vertebræ will vary according to the extent of the injury, and its locality. A moderate blow, especially an oblique one, upon the back, may simply knock off the spinous processes, or even fracture the laminæ without entailing anything beyond a moderate amount of concussion of the cord which will reveal itself by a paralysis of the lower extremities, disappearing after the lapse of some weeks or months; there will also be added some derangement of the secretory action of the kidneys. In other cases not even these disturbances will be present.

In a fracture of the bodies of the lumbar vertebræ there will be paralysis, commonly both of sensation and motion, of the legs; and paralysis of the bladder and rectum, so that the patient cannot pass the urine, or relieve his bowels; or those excretions pass away from him involuntarily. With these symptoms others are often associated, as crepitus, mobility of the fragments, and posterior angular projec-

tion of the spinous process of the fractured vertebræ, which will materially assist in removing any doubt in the mind of the surgeon as to the nature of the injury.

When the fracture is higher up—in the dorsal region—to the above enumerated symptoms must be added derangements of the stomach, nausea, vomiting, &c., and tympanitic distension of the abdomen. And, as it would be expected, when it is yet higher, but beneath the third cervical, the functions of the heart and lungs will also be disordered; there will be palpitation, difficulty in respiration, and congestion of the face from obstruction to the capillary circulation. The muscles of the chest and those of the upper extremities will also be paralyzed.

A fracture implicating the first three cervical vertebræ, which are above the phrenic nerve, and attended with displacement of the fragments and compression of the cord, must necessarily result in immediate death from asphyxia.

In all these cases the urine becomes alkaline, producing chronic inflammation of the bladder, which adds greatly to the sufferings of the patient.

Should the person survive the injury some time, inflammation arises in the cord and its membranes, and terminates in effusion and suppuration.

From the lowered vitality of the tissues pressure upon the sacral and gluteal regions causes sloughing sores; in some cases, the destruction is so rapid that the parts almost seem to melt away.

Diagnosis.—The nature and extent of a fracture of the spine cannot always be made out, for excepting the deformity, crepitus and mobility of the fragments, all the other symptoms may be, to a greater or less extent, the result of concussion, strains of the cervical muscles and ligaments, with damage to the cord, and dislocation of the vertebræ, and therefore, in certain cases, we are left altogether in the dark until an autopsy reveals the character of the injury.

Prognosis.—The prognosis will vary with the seat of injury. As we have already stated a fracture of the first three vertebræ accompanied with compression of the cord must be followed by death upon the spot; in those cases where the injury is seated in the lower cervical region the fatal issue is commonly delayed from three to seven days; in the dorsal, from one to four weeks, and in the lumbar region, from four to six weeks, or the patient may sometimes, in the latter case, survive the accident two or three years.

Death in these cases results from asphyxia, or from gradual exhaustion and nervous irritation often attended with profuse diarrhœa.

Fractures of the processes of the vertebræ, especially when unassociated with compression, are much more favorable than those of their bodies.

There are cases of these injuries recorded where patients have recovered to a greater or less extent, but they never regain the full enjoyment of all their bodily functions.

Treatment.—From the obscurity in the diagnosis of fracture of the vertebræ the greatest care and judgment are required in determining the

proper manipulative procedures to be employed. In case the spinous processes are broken and displaced, their position may be rectified, and the reduction maintained by laying two thick compresses upon either side of the spine and securing them with a broad body-bandage.

Fracture of the laminæ with depression has given rise to a good deal of discussion as to the propriety of operative interference to correct the displacement of the fragments; certain cases have been successfully treated by raising the depressed arch, but experience and reasoning do not sustain the utility of the operation as a general mode of practice. It will, in general, be better to place the patient in the easiest and most comfortable position upon a firm mattress or a water-bed, and to pursue an expectant plan of treatment; avoiding everything that would cause an unnecessary amount of motion of his body. Purgatives in the early part of the treatment should be avoided, and the urine must be removed with a catheter, as often as its accumulation renders it necessary.

Caution should be observed in making those changes in the position of the patient's body required for the purpose of changing his linen or bedclothes; and in no case should he be placed upon his face when the fracture is located in the cervical region and the thoracic muscles are paralyzed, for then the respiration is performed only by the diaphragm and the abdominal muscles, and to place the patient upon his belly under these circumstances would arrest the action of these muscles and thereby cause asphyxia.

Those portions of the back coming in contact with the bed must be protected as much as possible with air cushions, and should bed-sores form in spite of these precautions, they should be kept scrupulously cleansed, and covered with a dressing prepared by spreading lead plaster upon buckskin; after the sloughs have separated, stimulating applications of basilicon, storax, Labarraque's solution, &c., will be useful.

The occurrence of local inflammation at the seat of injury should be met by appropriate antiphlogistic remedies, leeching, and water-dressings.

At a later period, when the acute symptoms have disappeared, infrictions of the extremities with camphorated and stimulating liniments, containing the tincture of cantharides, and strychnia internally in doses of the one-sixteenth to the one-twelfth of a grain three times a day, will be serviceable in aiding the restoration of nervous power.

Fracture of the Sternum.—Fracture of the sternum is a rare form of injury in consequence of the elasticity of the thoracic walls and the spongy structure of this bone.

The fracture may be transverse, oblique, or longitudinal, the former being the most common; or, again, it may be simple, comminuted, or compound. It may be located at any point of the bone, but is most commonly encountered in the neighborhood of the junction of the manubrium with the middle piece. With advancing years the bone becomes more brittle, and it is late in life that the fracture is relatively most frequent.

Causes.—In a majority of cases the fracture results from direct injury, as the passage of a heavy wheel over the chest, or the fall of a

large piece of wood across it. Cases are reported in which it resulted from muscular action alone.

Symptoms.—The symptoms of this fracture will consist of those arising from the injury to the bone itself, and those from injury to the thoracic viscera. Among the former will be noticed displacement of the fragments, the lower one commonly slipping in front of the upper —a position due, according to Sanson, to the greater length of the ribs attached to the former portion; crepitus, which is more easily made out when the ear is applied to the chest, and pain at the seat of fracture. The symptoms dependent upon damage to the viscera of the chest are, palpitation, difficulty in breathing, cough, expectoration of blood, emphysema, and inflammation of the lungs and pleura. A case is reported in which the violence was so great as to drive a fragment of the bone into the heart and to cause death outright.

Prognosis.—As this injury always implies that great force has been inflicted upon the chest, especially when it occurs in young persons, the prognosis must in a majority of cases be unfavorable, and more particularly when the fracture results from direct violence and is complicated with disturbances of the thoracic organs. The occasional results of this injury are abscess of the anterior mediastinum, and caries or necrosis of the sternum.

Treatment.—When there is an overlapping of the fragments it has been recommended to effect the reduction by bending the body backwards over a pillow placed between the shoulders. Some surgeons direct the depressed bone to be raised by a lever, the point of which is placed beneath it, or to sink a screw into its substance and use this as a handle.

When the reduction has been effected a compress is to be laid over the point of injury and confined by a body bandage; the patient must be placed upon his back with the thighs drawn up and supported with pillows, while the head and shoulders are thrown somewhat posteriorly.

If an abscess should form in the mediastinum it should be opened as soon as it points at the margin of the sternum. Necrosis and caries of the bone are to be treated in the manner taught in general works on surgery.

FRACTURE OF THE RIBS.—Fracture of the ribs, though not so uncommon as that of the sternum, is yet comparatively infrequent. The cause of this is the elasticity of the walls of the chest, which of course is influenced to a greater or less extent by the age of the subject. The upper ribs are so effectually protected by the scapula behind and the clavicle in front, with their attached muscles, that their fracture is extremely rare. The floating ribs enjoy the same immunity by virtue of their mobility.

The fourth, fifth, sixth, and seventh ribs are most frequently fractured. Its line is generally transverse, though it often is oblique, and may even be somewhat longitudinal. Comminuted and compound fractures are met with in some cases, and in the latter instance result from the fragments of the bone penetrating either the lungs or skin.

Causes.—The causes are the same as those of fracture of the ster-

num—great force being applied to the chest producing the fracture directly or by counter-stroke; in the latter case, as when the chest is violently compressed between the bumpers of railroad cars, and the ribs break at some intermediate place between the points compressed. Malgaigne has recorded eight cases of fracture from muscular action.

Symptoms.—If there is displacement of the fragments of the broken ribs, which can only occur to any extent inwards or outwards, angular deformity will result—the angle being in the former case re-entrant or depressed, and in the latter salient; crepitus can be generally detected by directing the patient to breathe deeply, or what is better, cough, though in certain cases it may be masked by the swelling of the parts or emphysema; preternatural mobility of the fragment may also be made evident by pressure with the fingers. Besides these positive diagnostic signs there will almost always be present other symptoms indicating injury to the thoracic viscera, as cough, hæmoptysis, emphysema of the chest, severe pain over the seat of injury, or diffused over the chest and aggravated by coughing or sneezing; later, pleuritis or pneumonia may arise.

Prognosis.—We can always expect a favorable issue in a case of simple fracture of the ribs, particularly of the middle ones, when there is no displacement or only an outward projection of the fragments, in from twenty to thirty days.

If the fragments are driven inwards upon the viscera so as to wound them to any extent, the prognosis becomes very serious, for a large proportion of such cases will terminate fatally in a longer or shorter time from the inflammatory complications that will be set up. These cases are particularly serious in persons with a tendency to tuberculosis, as this disease is extremely apt to be developed.

Treatment.—The reduction of the fracture, if the fragments project exteriorly, is accomplished by pressing with the finger upon the angle which they form; if they are depressed upon the lungs and produce threatening symptoms, their elevation is indicated either with the fingers or an elevator introduced through the wound; should there be no wound, under circumstances of danger I think we should be justified in making one. Cases requiring such treatment must be exceedingly rare in civil practice; in gunshot wound of the chest I have been compelled, in a number of cases, to remove from the lungs spiculæ of bone an inch or more long. The only bandage required in these cases is one encircling the chest to retain the ribs immovable. A compress may or may not be placed beneath it over the seat of injury, according as there is or is not a tendency to displacement of the fragments externally.

Should the displacement be inwards a compress must be placed upon the anterior and posterior extremities of the ribs, and confined by a circular bandage. The bandage I am in the habit of using in these cases is composed of a number of adhesive strips two inches wide and long enough to encircle the chest once and a half, applied circularly and imbricated. After the bandage has been applied the patient should be placed in the most comfortable posture, and subsequent inflammatory complications combated by appropriate antiphlogistic remedies.

Fracture of the Costal Cartilages.—Fracture of the costal

cartilages arises from the same causes as fracture of the ribs. The eighth cartilage is most frequently affected, and in all cases the line of fracture is smooth and transverse. The usual displacement observed is the riding of the internal fragment over the outer one, if the seat of fracture is near the sternum, and the reverse when it is more remote.

Treatment.—The same general line of treatment must be observed in dealing with a case of fractured costal cartilage as has been pointed out at page 392, for the ribs. Malgaigne recommends, for the purpose of preventing displacement of the fragments, the application of a truss to the chest, one of the pads of which should press upon the seat of the fracture.

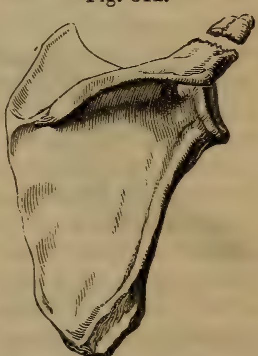
SECTION III.

FRACTURES OF THE BONES OF THE UPPER EXTREMITIES.

FRACTURE OF THE SCAPULA.—From the resiliency of the thoracic walls, the strength, mobility, and the thickness of the muscular coverings of the scapula, fracture of this bone is rather uncommon. It may affect the body, the neck, the coracoid or acromion process or the inferior angle of the bone.

1. Fracture of the acromion process (Fig. 312) is the most frequent variety met with in the scapula. It may be located either at, behind, or before the acromio-clavicular articulation: in the first two instances the shoulder losing the support of the clavicle will fall forwards and downwards; and in the latter the tip of the acromion will simply be depressed upon the head of the humerus. The direction of the fracture is generally transverse.

Fig. 312.



Fracture of the acromion process.

Cause.—Blows or falls upon the shoulder or elbow.

Symptoms.—The shoulder being no longer supported by the clavicle approximates to the median line, and is depressed; the head of the humerus falls into the axilla as far as the capsular ligament will allow; the arm hangs helplessly by the patient's side, who usually endeavors to take the weight of the limb off the fractured bone by supporting the elbow with the hand of the uninjured arm; if the hand be placed upon the shoulder while the elbow is forced upwards so as to bring the fragments in contact, crepitus will be perceptible; and lastly, in tracing the spine of the scapula, that portion of it between the fracture and clavicle will be found depressed.

Diagnosis.—Fracture of the acromion may be confounded with dislocation of the humerus into the axilla and fracture of the clavicle outside of the coracoid process. It is distinguished from the first by the circumstances that in fracture the deformity may be made to disappear by raising the elbow, and it will immediately be reproduced as soon as the support is removed, and the acromion will not present that prominent appearance it does in dislocation. Extra-coracoid

fracture of the clavicle will present little displacement of the fragments, no alteration in the rotundity of the shoulder, and the arm can be easily moved by the patient; these circumstances will suffice to distinguish this injury from fracture of the acromion process.

Prognosis.—The union between the fragments is usually ligamentous; and when it occurs by bone, it is generally with some obliquity of the outer fragment, which does not impair the free movements of the arm.

Treatment.—When the tip of the acromion is broken off, the best position for the arm is at right angles to the body, so that the deltoid muscle may be relaxed, and the fragment tilted upwards. As this position requires the patient to keep in a recumbent posture, he will perhaps decline the treatment; in that case, the only thing the surgeon can do is to support the arm in a sling. In those instances in which the shoulder loses the support of the clavicle, and falls downwards and forwards, the treatment is the same as that for fractured clavicle, except that the axillary cushion may be of equal thickness, as advised by Desault.

2. Fracture of the coracoid process (Fig. 313) is an extremely rare form of injury, and very difficult of diagnosis, from the situation of the bone, and the great amount of violence necessary to be inflicted to cause it, producing, at the same time, complications, such as fractures of the clavicle, scapula, and humerus, and contusions of the soft parts which effectually shield it from detection. The seat of the fracture may be in any part of the process, or even extend into the glenoid cavity.

Fig. 313.

Fracture of the coracoid process.

There can scarcely be much displacement of the fragments by the contraction of the short head of the biceps, coraco-brachialis, and pectoralis minor inserted into the process, unless, at the same time, there should be a rupture of the ligaments connecting it above with the acromion process and clavicle. In this case, it will take place downwards.

Symptoms.—The patient will be unable to adduct the arm, and, if there is not much swelling, the process may be grasped in the fingers, and moved so as to develop crepitus.

Treatment.—The indications of treatment are to render the scapula immovable by a body bandage crossing the injured shoulder, and to carry the elbow well forwards upon the chest, to relax those muscles inserted into the coracoid, and then to support the elbow and forearm in a sling.

3. Fracture of the neck of the scapula (Fig. 314) is also a very uncommon injury, and results from great violence inflicted upon the shoulder. It is sometimes attended with damage to the axillary plexus of nerves producing paralysis, and injury to the brachial artery. The line of fracture passes from the semilunar notch downwards to the anterior border

of the scapula, and therefore separates both the glenoid fossa and the coracoid process from the body of the bone. The weight of the limb carries the anterior fragment downwards and forwards.

Fig. 314.

Fracture of the neck of the scapula.

Symptoms.—There will be a depression observed beneath the acromion, giving the shoulder a depressed appearance, and the head of the humerus will be felt in the axilla; the limb, upon measurement, will be found longer than its fellow; crepitus is perceived when the surgeon places the tip of the index finger of the left hand upon the coracoid process, the rest of the fingers of that hand embracing the shoulder, while, with the right hand, he seizes the arm below, and moves it in various directions. The coracoid itself will be found at a greater distance from the clavicle, and obeying the movements of the humerus rather than, as it should, those of the scapula.

Diagnosis.—From dislocation of the head of the humerus into the axilla this injury may be distinguished by observing that in the latter the depression below the acromion is not so deep, and it may be effaced, and the rotundity of the shoulder restored by raising the elbow; the deformity being immediately restored the moment the support is withdrawn.

Fig. 315.

Apparatus for fracture of the neck of the scapula.

In fracture of the neck of the humerus the arm is shortened, and the rounded outline of the shoulder will not be disturbed.

Treatment.—The indications of treatment in this case are simply to render the scapula immovable, and to carry the anterior fragment upwards and outwards. They can be best fulfilled in the following manner: Place a pad in the axilla, with its base upwards; press the elbow towards the chest and a little to its front; surround the arm and chest with a body bandage; and lastly, support the elbow and forearm in a sling. Such an apparatus is seen in Fig. 315; the sling is not shown.

4. Fracture of the body of the scapula is produced by great violence inflicted upon the chest, and is usually accompanied with considerable injury to the soft parts surrounding the bone, producing

such an amount of swelling as to obscure the nature of the injury. The resulting inflammation is often so severe as to eventuate in necrosis of the bone, and impairment of the functions of the upper extremity which either happens at once or succeeds to the injury.

Fig. 316.

The ordinary situation of fracture of the body of the scapula.

The fracture may be incomplete, simple, or comminuted, and the line of its direction vertical, transverse, or oblique. Any portion of the body may suffer, the spine or the portions above or below this; but it is most commonly seated below the spine, running obliquely from the anterior to the posterior border, as seen in Fig. 316.

There will not be much, if any, displacement of the fragments in a vertical fracture; but in a transverse one they will be separated, the levator of the angle of the scapula, and the rhomboid muscles drawing the superior fragment upwards; while the serratus magnus, latissimus dorsi and teres major draw the inferior one downwards.

Symptoms.—If the case is seen early, by carefully examining the borders and angles of the scapula any fissure or separation of the bone may be detected; to facilitate the examination, the arm should be moved in different directions, so as to give greater prominence to the different portions of the scapula. In these movements, crepitus may often be perceived by reposing the hand over the bone. The functions of the arm will be more or less impaired, from the combined injury to the bone and to the soft parts surrounding it.

Treatment.—The only bandage required in this case is to sling the elbow and forearm so as to raise the shoulder, that the muscles inserted into the upper fragment of the scapula may be relaxed, and the portions of bone thus brought into contact.

5. Fracture of the inferior angle of the scapula arises from the same causes as produce the same injury of the body of the bone. The nature of the displacement will depend upon the extent of the muscular insertions into the angle spared; the serratus magnus alone will carry the fragment forwards, while it, in conjunction with the latissimus dorsi and the teres major, will displace it forwards and upwards, or forwards and downwards.

Symptoms.—There will be mobility of the separated angle, and crepitus can always be produced by moving the fragments in opposite directions; these symptoms, with a knowledge of the history of the case, will enable the surgeon to make a correct diagnosis.

Treatment.—It must always be borne in mind that in all transverse fractures of the scapula great difficulty will be encountered in maintaining the fragments in contact; and even when it is effected, they will usually unite awry. It is, however, consoling to know that this result cannot impair the usefulness of the arm.

In applying the retentive bandage, authors have differed considerably as to the best position in which to place the arm. Some direct the elbow to be carried in front of the chest, some to the rear, while others prefer to retain it in a line parallel with the vertical axis of the body. The axillary pad has been considered necessary by some, and has been condemned as useless by others.

In the midst of these conflicting opinions, it would appear the most rational plan to reduce the fracture, and place a thick compress along the anterior border of the scapula, then to surround the chest with a broad bandage passing from the injured to the sound side; the scapula being rendered immovable, the arm should be put in that position which most completely relaxes the muscles inserted into the fractured angle, and prevents displacement. It may be that this requires the elbow to be moved in front of the chest, towards the posterior aspect, or retained in a vertical direction. When the object has been obtained, the limb is to be secured by a circular bandage embracing the arm and chest, while the forearm and elbow are supported in a sling.

Desault advises an axillary pad, with its apex looking upwards, so that the elbow may be kept away from the side. This plan may be adopted or rejected, according as it secures the object in view or not.

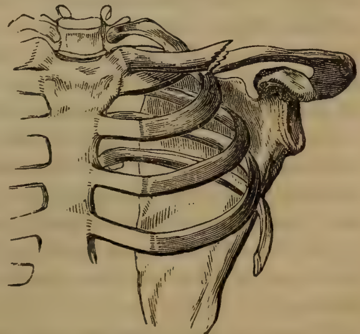
Fracture of the Clavicle.—From the peculiar curved shape, slenderness, exposed position, and functions of the clavicle, it is frequently broken. According to the statistics of Malgaigne, of 2358 cases of fracture of different bones, 228 were of the clavicle, and of these three-fourths were met with in the male. It is encountered in all ages, from infancy to old age.

The fracture may be unilateral or bilateral, complete or incomplete, simple or comminuted or compound; the most common variety being the simple, while the others are comparatively rare. The line of fracture is almost invariably more or less oblique, and often distinctly serrated. Its seat is generally in the middle third of the bone, to the inner side of the coraco-clavicular ligament, a circumstance which is explained by the fact that at this point the clavicle is more slender than elsewhere, and it also begins here to change the direction of its curve, so that an extraneous force must necessarily act upon this spot more energetically than upon any other.

Causes.—The most common cause of fractured clavicle is by counter-stroke from falls upon the point of the shoulder; direct violence also produces the same result. In a few recorded examples, muscular action was the cause.

The line of fracture of the middle third, in a majority of cases, is oblique from above downwards and inwards, as seen in Fig. 317; so that the shoulder, losing the support of the clavicle, will be drawn by the weight of the

Fig. 317.



Oblique fracture near the middle of the clavicle.

upper extremity downwards, while the contraction of the subclavius and pectoralis major and minor will give it a direction forwards and inwards. The sternal fragment, stayed above by the sterno-cleido-mastoid muscle, and below by the costo-clavicular ligament, maintains nearly its natural position, or is simply elevated a little; on the other hand, the acromial fragment, following the movements of the shoulder, will overlap the former upon its under surface for half an inch or more. When the line of fracture is in the reverse direction, as it sometimes is, the inner extremity of the outer fragment will be, in a measure, sustained.

Displacement of the pieces in fracture seated between the insertion of the sterno-cleido-mastoid and the attachments of the costo-clavicular ligament, or between the coraco-clavicular ligaments, cannot take place to any extent, while a fracture outside of the latter ligaments will be attended with a posterior displacement of the external fragment, which will unite with anterior angular deformity in spite of the best treatment.

Symptoms.—Besides the apparent deformity caused by the displacement of the fragments above described, if the fingers are conducted along the clavicle from within outwards, they will suddenly encounter a depression at the seat of injury, and they will then pass on to the acromion upon a lower plane formed by the outer fragment; crepitus will be perceived when the pieces of bone are seized between the fingers and rubbed upon one another, or better brought into contact by drawing the shoulder outwards; the arm hangs by the body, and is rotated inwards; the patient inclines his head to the damaged side, and instinctively endeavors to support the shoulder by holding the forearm in the hand of the sound limb; there will be severe pain about the fractured bone, which is aggravated by the slightest motions of the arm. The functions of the upper extremity will generally be more or less destroyed, though it is not uncommon to meet with patients who can lift the hand of the injured side over the head.

Contusions should be sought upon the point of the shoulder or elbow where the injury has resulted from counter-stroke, or over the clavicle when from direct injury.

In fractures of the inner and outer thirds of the clavicle deformity will not be so apparent, and therefore these cases require the closest scrutiny to arrive at a correct diagnosis.

The same remark likewise applies to incomplete fracture, which generally occurs in young subjects, and is characterized by a node-like swelling at the seat of injury, obscure crepitus, and impairment of the functions of the limb, and when the point of injury is pressed upon with the tip of the finger severe pain is caused.

Prognosis.—In simple fracture of the clavicle by contre-coup the patient, if he be an adult, will generally do well, and consolidation will occur in about five weeks; in a child, union occurs in eighteen or twenty days. Fractures from direct blows upon the clavicle are not so favorable, nor are those which are comminuted, compound, or complicated.

The subclavian nerves and vessels may be so injured as to cause paralysis or aneurism, and even death. A case of compound commi-

nuted fracture from gunshot came under my care, in which the subclavian artery was laid bare and could be seen plainly pulsating at the bottom of the wound; the patient recovered after a tedious illness and necrosis of more than half of the clavicle.

Treatment.—The reduction of the fracture is very easily accomplished by simply raising the elbow and pressing the shoulder outwards, or by approximating the shoulders posteriorly, the knee having been previously placed between the scapulæ. As a general rule, it may be stated that though the reduction is so easy, yet in those cases of complete oblique fracture of the adult it will be impossible to retain it by any apparatus whatever, and union will therefore occur with some degree of overlapping or deformity.

The indications of treatment are plain, the shoulder must be carried *upwards, outwards,* and backwards. The difficulties encountered in the treatment are not that these indications cannot be fulfilled temporarily with suitable bandages, but that, sooner or later, the apparatus, of any description whatever, will become deranged or loosened while the patient is permitted to move around as he ordinarily is during the treatment, and thus the object in view—immobility of the clavicle—will almost certainly be defeated.

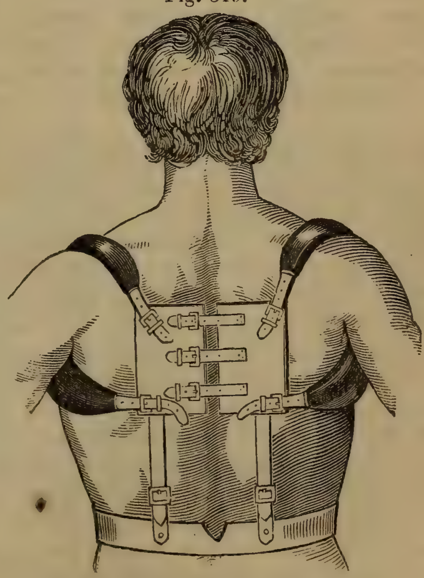
To facilitate the comprehension of the various contrivances which have been employed in the treatment of this injury, we shall divide them into three classes, according to their mode of action:—

1. *Apparatus which fulfil one indication only, namely, maintaining the shoulder backwards.*—Under this heading are to be placed the

Fig. 318.

Figure of 8 bandage for fractured clavicle.

Fig. 319.



Brasdor's apparatus for fractured clavicle.

posterior figure of 8 bandage of the shoulders and its numerous modifications.

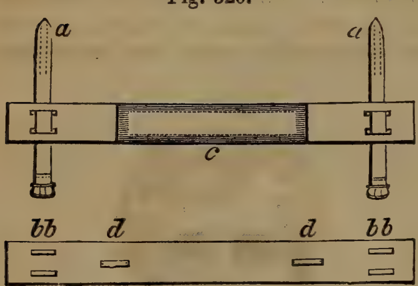
The figure of 8 bandage may be applied as seen in Fig. 318, which shows also the combination with it of an axillary pad and a circular bandage for the purpose of throwing the shoulder outwards. Without these modifications the figure of 8 bandage was employed by Albucasis and the Arabian school of surgeons. In France it found supporters in Guy de Chauliac, Lanfranc, and A. Paré; J. L. Petit, following the example of Hippocrates, enjoined an inter-scapulary compress.

Brasdor employed a corselet, consisting of a dorsal plate with lateral straps for the shoulders, and steadied by a circular belt around the waist, as seen in Fig. 319.

In Germany, Heister brought forward his dorsal iron cross with lateral straps, and subsequently Bruninghausen employed transverse leather straps connected with shoulder-pieces. Hubenthal, Brefield, Koppenstater, Eicheiner, and Evers invented apparatus based upon the same principle (see *Atlas* of J. F. Behrend, Plate 13).

In this country there are still some apparatus employed which act in the same manner as the figure of 8 bandage; of these one invented by Dr. Kecherly is seen in Fig. 320. "The upper figure exhibits a front view, and the lower a back view of the splint. *a, a,* are two bandages with buckles attached to one end of each; *bb, bb,* are four mortised holes for the passage of the two bandages; *a, a, c,* a portion of the splint padded, to prevent its bruising the patient; *d, d,* two loops of leather, tacked on the back of the splint, for the passage of the bandages, where the mortised holes are too far apart for the breadth of the patient from shoulder to shoulder." In applying this apparatus "the end of the splint corresponding to the uninjured side is to be pressed close to the back of the shoulder, and retained so by drawing the bandage tight, and retaining it by means of a buckle. Previous to fixing the bandage, it should be passed through two loops on a small pad, which is to be placed in the axilla. This pad is used for the purpose of preventing cutting of the bandage. After passing the other bandage through two loops, on a large cuneiform pad, which is placed in the axilla of the injured side, it is drawn sufficiently tight and secured by the buckle. The last thing to be done is to place the handkerchief, doubled in a triangular form, in such a manner over the arm, the front and back parts of the thorax, as that it shall draw and confine the arm of the injured side close to the body, give it support, and prevent its falling down."

Fig. 320.



Kecherly's apparatus for fractured clavicle.

2. *Apparatus which fulfil two of the indications, namely, sustaining the shoulder upwards and backwards.*—Although we find these two indications carried in the spica, scarf, and sling bandages of Hippocrates, Celsus, Paulus Ægineta, and Galen, yet in modern times

surgeons have not had the same confidence in this class as in the former. The spica of Glaucius, described by Galen, is stated by Velpeau to be the original of Desault's bandage. L. Richter and Gluge have employed the descending spica of the arm.

M. Mayor recommends a bandage prepared with a square piece of muslin folded in a triangle, the base of which was placed between the arm and chest, the lateral angles extending around the latter, while the depending angle was carried beneath the elbow, brought up over the forearm and chest, and its two parts separated, one angle passing over each shoulder and fastening to the bandage behind. He believed that in a majority of cases this bandage would be efficient, but should the deformity persist, he directs an axillary pad to be used.

M. Velpeau has described a bandage which he speaks of in the following manner: "I have contrived a bandage, by means of a simple roller, which is adapted both to sterno-clavicular luxations, for which I had at first designed it, and also to acromio-clavicular luxations, fractures of the clavicle, acromion, and scapula, and even to fracture of the neck of the humerus. For this purpose we procure a bandage of eight to ten yards in length. The head of this bandage is first applied under the armpit of the sound side, or behind, as with the cataphrast; it is then passed diagonally upon the back and shoulder to the clavicle, upon the side affected. The hand of the patient is then placed upon the acromion of the sound shoulder, as if embracing this last. The elbow thus raised is brought in front of the point of the sternum, and the affected shoulder is pushed upward, backward, and outward, by the action of the humerus, which taking its *point d'appui* on the side of the chest, acts like a lever of the first kind, or by a swing-like motion. While an assistant keeps the parts in place, the surgeon brings down the bandage upon the anterior surface of the arm, then outside and under the elbow, to bring it upward and forward under the sound armpit. He repeats this three or four times, in order to have that number of diagonal turns, which obliquely traverse the wounded clavicle, the upper part of the chest, and the middle portion of the arm. In place

Fig. 321.

Velpeau's apparatus for fractured clavicle.

of bringing back the bandage to the affected shoulder, it is afterwards passed horizontally upon the posterior surface of the thorax, and brought back upon the external surface of the arm, elbow, or forearm, in the form of circulars, which are repeated until the hand which is on the sound shoulder and the stump of the affected one alone remain uncovered. We finish by one or two more diagonals, and by a similar number of horizontal circulars.

"Another bandage, well saturated with dextrine, and applied exactly in the same manner over the first, makes a kind of immovable sac, in which the elbow rests without effort, and without having the power to move itself either backwards, outwards, or forwards. I have already employed it a great number of times, and it has appeared to me so simple, and of such easy application, that I do not hesitate to offer it as preferable to all those that have been hitherto proposed."

The arm may be very conveniently and efficiently supported in the position recommended by Velpeau by means of long strips of adhesive plaster, about an inch and a half or two inches wide, passing obliquely around the arm and sound shoulder, and circularly around the chest. If it is deemed necessary an axillary pad may be employed, though generally it will not be required. Wattman's bandage is similar to this.

A dextrine bandage is also recommended by Chassaignac (*Gazette des Hôpitaux,* 1853). He bends the arm of the injured side at an angle of 90°, covers the forearm and lower half of the arm with a layer of carded cotton, and over this applies a roller soaked in a solution of dextrine. He now reduces the fracture, places a compress over the lateral and posterior surface of the neck of the sound side and another between the chest and forearm; with a second dextrined roller he secures the arm to the thorax by oblique turns running beneath the elbow and across the cervical compress.

Richerand and B. Bell employed simple slings to support the arm.

3. *Apparatus which fulfil the three indications of supporting the shoulder backwards, upwards, and outwards.*—The first decided progress made in the treatment of fractured clavicle was after the introduction of the bandage of Desault, which fulfilled the indications above mentioned better than any contrivance that had been used up to that time. It is executed with three rollers each three inches wide and eight yards long; a wedge-shaped cushion three inches wide at its base and seven inches long, gradually tapering towards the apex. In applying it the patient is seated upon a stool, or stands erect, while an assistant holds the injured arm at right angles with the body; the surgeon places the wedge in the axilla with its base upwards and has it supported close to the body until he has placed the initial extremity of the first roller upon it and made three circular turns around the chest and the wedge to sustain the latter in its position, then the roller is conducted in front of the thorax over the sound shoulder under the corresponding axilla to appear in front again, thence around to the back, over the sound shoulder down in front of the axilla, beneath this to the back, when the roller is exhausted by circular turns around the chest, each turn overlapping two-thirds of the width of its predecessor.

The arm is now brought against the wedge and the forearm flexed at right angles, carrying the elbow a little in front of the chest when the second roller is to be applied in the following manner: place its initial extremity under the axilla of the sound side, conduct its head obliquely across the chest, to the acromion around the upper part of the arm and chest, to the axilla again, its point of departure; thus continue with the circular turns until the arm and upper half of the forearm are covered in. This roller answers the important indication of forcing the shoulder outwards, the humerus being used as a lever of the first kind acting upon the axillary wedge as a fulcrum; hence it is important that the lower turns acting upon the elbow should be drawn tighter than those above.

The third roller serves the purpose of keeping the shoulder upwards and backwards, and is applied by placing its initial extremity under the axilla of the sound side, then conduct the cylinder over the broken clavicle, upon which a compress must be placed, down the posterior surface of the arm under the elbow, and over the forearm to the point of departure; thence across the back obliquely over the injured shoulder, down the front of the arm and under the elbow, to pass obliquely across the chest to the axilla of the sound side. In this manner two triangles are formed, one in front and the other upon the posterior surface of the chest; continue to lay on these turns until the roller is completed. The forearm is supported in a sling.

This bandage becomes loosened and requires to be tightened every five or six days, or even more often according to circumstances.

It keeps the patient under a good deal of restraint, and the turns of the roller often compress the thorax painfully, particularly in women. Cloquet states that at the hospital of St. Louis the third roller was omitted, and a sling for the elbow and forearm substituted. He further says that the treatment was usually successful, and the modified bandage could easily be borne by women.

Dupuytren, Cruveilhier, and Flamant also employed a bandage formed of two rollers.

In order to remedy the defects in the apparatus of Desault, Boyer invented a bandage which bears his name. It consists of an axillary pad made of bran, placed in the axilla and supported by two ribbons fastened to its superior angles and tied over the sound shoulder; of a belt of quilted muslin five inches wide, to surround the chest, and fastened by three buckles and a corresponding number of straps; of an armlet of the same material some four or five inches wide, lacing upon the arm; to the armlet four straps are attached, two in front and two behind, and which pass through corresponding buckles upon the thoracic belt anteriorly and posteriorly. These straps are the characteristic feature of Boyer's bandage; with them the power is applied to throw the shoulder outward. The forearm is supported in a sling.

Böttcher omits the armlet, and incloses the lower part of the arm with the thoracic belt.

Delpech's apparatus is formed of, 1st, a body bandage of stout muslin extending from the axilla to a point about two inches above the

crest of the ilium, gored at the sides, and fastening in front by six buckles and a corresponding number of straps; to prevent the bandage slipping down it is supported by shoulder-straps, while four thin strips of whalebone, sewed in the muslin, keep it from working into ridges; two loops made of muslin are fastened to a point of the bandage about two inches from its upper margin. 2d. A wedge-shaped pad, with a width at its base the diameter of the arm, and long enough to reach from the axilla to the elbow; the pad is sewed to the body bandage so that its base exactly occupies the axilla. He directs the pad to be made of quilted horsehair and covered first with a layer of quilted wool and then with a second layer of carded cotton also quilted; the whole to be nicely covered with muslin. 3d. A four-tailed sling of sheepskin covered with chamois and well padded with cotton at the centre to receive the elbow. Each of the heads of the sling are split into two short straps, the anterior being pierced with holes and the posterior provided with four buckles. In using the apparatus the body bandage is to be neatly applied, with the axillary pad in its proper position, the elbow is brought to the side and engaged in the body of the sling, the posterior straps are carried obliquely across the back, and engaged in the loop near the upper border of the bandage, the two inferior buckles being conducted over the shoulder, and the two superior under the axilla; the anterior straps are also engaged in their loop, and the two lower tongues engaged in the buckles coming over the shoulder, and the upper ones into those appearing beneath the axilla.

From the descriptions of the above bandages it will be seen, that in France in the treatment of fractured clavicle the forearm was always placed in front of the body, and supported either with a sling or with the turns of a roller.

M. Guillou (*L'Abeille Médicale*, October, 1847) reported to the Academy of Science of Paris an innovation upon this plan; he stated that, for some years, he had been in the habit of treating fracture of the clavicle by placing the forearm across the back of the chest, instead of in front, as was the general custom, and that his success justified him in preferring this method to all others.

This apparatus consisted of—1st. A sling made of a folded handkerchief of an appropriate length; 2d, a cravat; 3d, of a body bandage; 4th, a square cushion of linen, thicker in its middle than along its margins; 5th, a pad having a ribbon a foot and a half long attached to each side of its base. In employing the bandage place the wedge-shaped pad in the axilla and sustain it in that position by tying the ribbon attached to it over the opposite shoulder. The body of the cravat is put around the upper part of the injured arm and its tails carried behind the shoulder; the arm is now brought to the side while the forearm is thrown across the back and supported in the sling depending from the neck; the square compress is laid between the scapulæ and sustained in this position by the tails of the cravat, which are now made to cross it, and to tie around the sound shoulder; lastly, the body bandage is made to surround the chest and arm, and is to be securely pinned.

The actions of the different parts of the bandage are obvious; the sling raises the shoulder; the body bandage presses it outward by acting upon the humerus as a lever; while the cravat pulls the shoulder outward, the square cushion over which it passes giving it greater leverage.

This apparatus of Guillou, as may readily be conceived, is at first very irksome to the patient from the unusual position in which the arm is placed; but in a few days he will generally become reconciled to it. More serious objections, however, to the bandage are, that it interferes with a comfortable indulgence in recumbency, and rotates the arm inwards, so as to throw the axillary vessels and nerves more directly against the pad.

Mr. Lonsdale (*Treatise on Fractures*, pp. 212, 213) describes a very simple bandage, seen in Fig. 322. It consists of a wedge-shaped pad, secured in the axilla with a roller, upon which the arm is to be laid. The elbow is drawn to the front of the chest, and confined by a few turns of a roller around them, while the forearm and elbow are supported in a short sling, as shown in the figure.

Fig. 322.

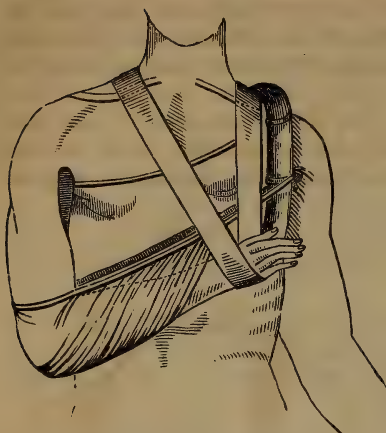
Lonsdale's apparatus for fractured clavicle.

In America, perhaps, no apparatus has been so popular, or so generally employed as that invented by Dr. Fox in 1828 (Fig. 323). It is extremely simple, and the materials of which it is prepared may be obtained almost everywhere; and lastly, it answers as well in the treatment of fractured clavicle as any of the bandages yet suggested. As to its asserted efficacy in accomplishing cures without deformity in all cases of this injury, there is certainly a mistake, arising, perhaps, from want of accurate observation. Its superiority over other sling bandages that have been in use in Europe for years, and descriptions of some of which we have already given, consists in the simplicity of the materials used in making it, and the ease with which it can be prepared.

The bandage is composed of, 1st, an axillary wedged-shaped pad, about half the length of the humerus, and with a thickness at the base of two and a half to three inches; just enough, in fact, to keep the arm free from, and parallel with the side, and having attached to its base two long tapes. 2d. A padded ring, an inch or two thick, and sufficiently large to embrace the shoulder. 3d. A sling, made of muslin, and extending from the middle of the humerus to the wrist, having attached to its superior border one tape, and two tapes to its inferior angles. 4th. A sling for the hand.

In applying the apparatus, slip the padded ring over the sound shoulder; then place the pad in the axilla of the injured side, and support it in position by tying the two tapes attached to its base, to the padded ring, before and behind. Now bring the arm, bent

Fig. 323.



Fox's apparatus for fractured clavicle.

at right angles, against the pad; place the elbow in the sling; then carry the upper tapes behind the chest, and the other two in front, and tie them to the padded ring; the hand is supported in the sling.

In Fox's apparatus the pad serves the purpose of a fulcrum, upon which the humerus is made to move as a lever of the first kind, by applying power to the lower part of the arm with the aid of the tapes. The head of the humerus may thus be thrown outwards and backwards as far as may be required to effect the reduction of the fracture, by simply varying the tension of the tapes.

Dr. Hamilton has suggested a desirable modification of Fox's apparatus, to obviate pressure upon the axillary vessels and nerves. It consists in allowing the arm to hang vertically beside the chest, and in employing a pad that will just fill the axilla when the elbow is in contact with the body. He says that "in consequence of having placed the elbow further back than is recommended by Dr. Fox, it will be necessary, also, to vary in some way the suspensory tapes; those coming from the humeral portion of the arm-tray must pass in equal numbers and in opposite directions, before and behind the body, towards the stuffed collar; and each set of front and back tapes, attached to the humeral portion of the tray, must be in pairs, for the convenience of tying. I find it necessary, also, to secure the arm to the body by two or three turns of a roller, applied always lightly and with great care, so that its pressure shall be in no degree painful or uncomfortable." The proper application of this apparatus is seen in Fig. 324.

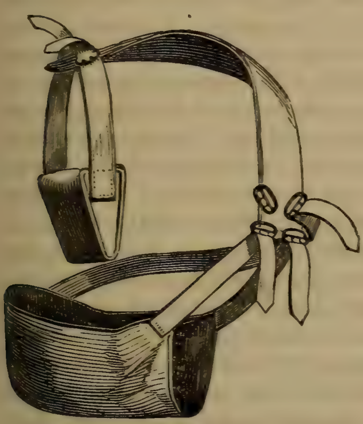
Fig. 324.

Hamilton's apparatus for fractured clavicle.

Another ingenious form of the sling bandage is the one contrived by Dr. R. J. Levis, of Philadelphia (Fig. 325). As described by him, it consists of a short, firm pad in the axilla, by which the shoulder is held from the side, and over which, as a fulcrum, the elbow is drawn to the side. To the front and back of the axillary pad are fastened straps, which pass directly upwards, and are buckled to a wide main supporting band, which passes from the shoulder across the upper part of the back, and over

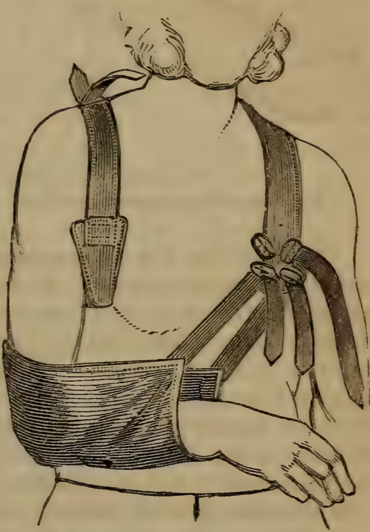
the shoulder of the sound side, and terminates on the front of the chest. By this means the shoulder is supported, and the pad immovably held high in the axilla, where its pressure can be more conveniently borne than when its widest part compresses the brachial nerves and vessels lower down; besides, a better leverage is thus given to the arm over the pad. To the front end of the wide supporting band is suspended a sling, by which the elbow is supported. On the back of the sling, at a short distance above the point

Fig. 325.



Levis's apparatus for fractured clavicle.

Fig. 326.



Levis's apparatus applied.

of the elbow, a strap is attached, which passes obliquely across the back, and, coming in front, is buckled to the main supporting band. The action of this strap is to draw the elbow to the side, at the same time supporting it; and its opposite attachment in front prevents the tendency of the wide band to ride upward and press uncomfortably on the superficial vessels of the neck.

By this combination, united so as to form one continuous piece, requiring no extra bandage over it, the shoulder is firmly held in the proper direction without any risk of yielding or slipping of the apparatus, and so secure that the most restless patient cannot disarrange it.

In adjusting the apparatus, the arm is passed through the opening above the pad, the wide band thrown across the opposite shoulder, the elbow placed in the sling, and the long strap attached to the back of the sling brought round in front.

In removing it from the patient, it is only requisite to loosen the back strap which draws in the elbow, by unbuckling it at its front attachment. The other straps need never be removed from the buckles.

The extra buckle, which will be noticed at the front end of the wide

supporting band, comes into use when the apparatus is reversed for the opposite shoulder.

The apparatus may be made of any strong material, as webbing, drilling, or soft leather. The width of the wide band should be from two to four inches. The straps which press upon the surface were slightly padded in the apparatus as the inventor has used it, but this may not always be essential, and temporary pads might be placed if the pressure should become anywhere uncomfortable. Thus constructed, it can be very speedily prepared at an emergency, and buttons and buttonholes might even take the place of buckles.

Probably the true principle of treatment in dealing with fracture of the clavicle, especially in its middle third, is to act upon the lower posterior angle of the scapula of the injured side, and to some extent upon its inner and posterior margin, by pressing it upwards, backwards, and outwards, so as to make a lever of it with the posterior surface of the thorax as a fulcrum, and thus by restoring the scapula to its proper position at the same time to restore the shoulder and with it reduce the fragments to their proper apposition. The weight of the upper extremity, which is the chief cause of the falling or drooping of the shoulder, should be removed by a sling upon the flexed forearm or by a pillow in case the patient is confined to bed; and the pressure on the scapula may be effected by confining the patient in the supine position with a firm, hard pillow or compress broad and long enough to make decided pressure on the whole back of the chest, or with a compress so applied and maintained as to press especially upon the lower and inner posterior margin of the scapula of the injured side. The old instrument of Brasdor will answer this purpose with slight modifications and was probably intended to do so by its author; but a firmer and more efficient apparatus has been proposed by Dr. Edward Hartshorne, of this city. Dr. Hartshorne advocated this principle of treatment some years ago at the Pennsylvania Hospital, and demonstrated its mode of action upon patients in the wards where he had long preferred the confinement of patients on their backs, whenever practicable. More recently, a very similar idea has been expressed and very fully explained by Dr. John H. Packard, in his Mütter lectures before the Philadelphia College of Physicians. In a paper ("On Fractures of the Upper Extremities," *New York Med. Journ.*, Nov. 1866, pp. 93 to 105 inclusive) founded on these lectures, he attributes most of the displacing action to the serratus magnus and pectoralis minor, in addition to that of the weight of the limb, and recommends "carrying the scapula backwards" by "acting on the head of the humerus, either by a figure of 8 bandage, properly applied and bearing on the sound shoulder, the elbow being carried forwards and well supported, or by a cap of muslin or linen, so made as to embrace the upper part of the arm, and fastened in the same way." Dr. Packard refers also to the bandage described by Dr. J. C. Palmer, Surgeon U. S. N., in the *American Journal of Medical Sciences* for July, 1863, as "a very comfortable contrivance for this purpose."

Dr. Hartshorne is disposed to regard other large muscles of the chest and shoulders as more or less concerned in aiding that of the two

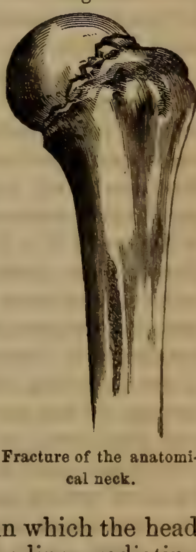
particularly mentioned, especially when an axillary pad is used to irritate and distend the armpit, and he prefers a more decided action on the lower angle of the scapula, together with such pressure on the shoulder as may press it backwards without interfering with the pressure upwards and outwards. The action of pressure upon the angle of the scapula in restoring the shoulder and reducing the fracture by extension of the outer fragment is very well shown upon a slender child of from five to ten years of age in whom the parts are well exposed and the weight of the limb is slight. It was repeatedly shown in this way by Dr. Hartshorne at the Pennsylvania Hospital, but although to some extent realized and acted on by surgeons elsewhere, it does not appear to have been sufficiently enforced. The same principle of treatment was unquestionably carried out, without its being recognized, in the apparatus of Hippocrates, J. L. Petit, and Guillou, possessing interscapulary pads.

Other forms of apparatus have been brought into notice recently, and used with success in the hands of their inventors. Among these we shall mention Hinton's "yoke splint" modified by Day, Welch's and Bartlett's apparatus.

FRACTURE OF THE HUMERUS.—The humerus may be broken in any part of its length, and in order to convey a clear idea of the nature, causes, and treatment of this injury as it is seated in different localities, the subject requires consideration under distinct heads; and first, commencing above, we shall describe—

1. *Fracture through the Anatomical Neck of the Humerus* (*intra-capsular*).—This form of fracture is caused by direct blows or falls upon the shoulder, or gunshot. Its direction is such that that portion of the head incrusted with cartilage is separated from the shaft of the bone; it does not generally suffer any displacement, though in certain recorded cases the upper fragment has been found more or less twisted out of position, and impacted into the cellular substance of the tubercles.

Fig. 327.



Fracture of the anatomical neck.

Symptoms.—The arm will be found of the same length as the opposite one, unless there is considerable impaction, in which case there will be some shortening; the elbow hangs by the side, and the patient can move the arm pretty freely. By pressing the humerus towards the glenoid cavity, and rotating it, crepitus may be produced; a very slight depression will be observed beneath the acromion.

Treatment.—No splints will be required in the case; the arm should be brought to the side, and the forearm supported in a sling. If the head of the bone becomes necrosed, it must be removed. This result will most frequently occur in those cases in which the head of the bone is split into a number of fragments by lines radiating from its centre.

2. *Fracture through the Tubercles of the Humerus* (*extra-capsular*).—The tubercles comprehend the space included between the anatomical

and surgical necks. This is a rare form of fracture, and generally results from direct blows applied to the shoulder.

Symptoms.—There will not usually be found any shortening, though, as in the previous case, the fragments may be impacted, when accurate measurements with the tape-line will show perhaps a little; displacement does not often occur, nor are the functions of the arm impaired, unless the muscles be badly bruised. By rotating the arm, crepitus may be perceptible to the hand placed upon the shoulder; the arm hangs by the side naturally, and there will be no depression beneath the acromion.

Treatment.—No apparatus is usually required, except to place the limb by the side and support it in a sling. If there should be marked displacement, however, either Erichsen's or Welch's splint may be applied. Local inflammation should be combated by appropriate antiphlogistic measures.

3. *Vertical Fracture of the Head of the Humerus, separating the Greater Tubercle* (*extra-capsular*).—In this fracture the greater tubercle is separated from the head of the humerus, and is generally somewhat displaced under the coracoid process. It is caused by blows upon the front of the shoulder.

Symptoms.—The arm will preserve its normal length, and, barring the effects of the injury upon the muscles, it will possess the power of pretty free motion in every direction, and the hand can be placed upon the opposite shoulder. The elbow rests alongside of the body, or perhaps may incline a little backwards. The tubercle may be felt beneath the coracoid process, and its displacement increases the antero-posterior diameter of the upper end of the humerus. A slight depression may be observed beneath the acromion, and if the tubercle is fixed with the fingers, while the arm is being rotated, crepitus may be elicited.

Treatment.—Combat local inflammation, place the forearm in a sling, and confine the arm to the chest with a few turns of a roller.

4. *Fracture of the Surgical Neck of the Humerus* (Fig. 328).—The "surgical neck" of the humerus embraces the space extending from the base of the tubercles to the insertions of the latissimus dorsi and pectoralis major.

Fracture of this portion is the most common form of this kind of injury affecting the upper extremity of the humerus.

It is met with in childhood and adult age; in the former case the line of fracture will generally correspond with that of the epiphyseal junction.

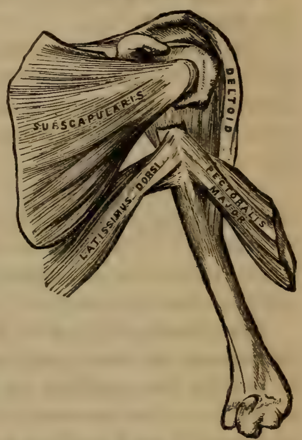
Causes.—The most frequent cause is direct injury applied to the shoulder; sometimes it results from falls upon the elbow and hand, and Vidal records a case in which it proceeded from muscular action.

Symptoms.—There will not generally be found a complete displacement of the fragments from each other, either in consequence of the close connection of the long head of the biceps to them, or from their being impacted, so that under these circumstances no shortening will be encountered. Sometimes, however, the reverse occurs, the supraspinatus, infra-spinatus and teres minor muscles draw the upper frag-

ment forwards and outwards, while the lower one, obeying the action of the pectoralis major, latissimus and teres major, will be pulled inwards, and subsequently upwards towards the coracoid process by the triceps, biceps, and coraco-brachialis. In this case the arm will be more or less shortened.

Although the above described displacement is the most common, yet there are recorded examples where the ends of both fragments have been thrown inwards, forwards or outwards. Both Desault and Dupuytren have seen the lower piece projecting outwards, under the deltoid, and the former surgeon states that it has even pierced that muscle, and appeared externally.

Fig. 328.



Fracture of the surgical neck of the humerus.

Where the fragments are not separated crepitus may easily be developed by moving the arm in various directions; there will be some slight depression below the acromion, or at least some want of fulness of the deltoid. The patient will be generally unable to place his hand upon the opposite shoulder unless the fragments mutually sustain each other by contact or impaction. In this latter condition of the bone its head will be found to move consentaneously with the shaft, while in a complete separation this will not be the case, the fingers can feel the head motionless in the glenoid fossa in whatever direction the arm may be moved. The position of the arm is also different in these two conditions, hanging vertically against the chest, when the fragments are not displaced, and sloping a little outwards with the elbow away from the chest when they are.

Prognosis.—This injury requires that all the circumstances of the case should be carefully examined before a prognosis is given. There is often a good deal of difficulty encountered in maintaining the fragments in contact, and deformity and impairment of the functions of the limb result.

It has been denied by some surgeons that bony union ever occurs at this point, but they say that the upper fragment becomes hollowed out into a cup-shaped cavity, which receives the upper end of the lower one, and thus forms a sort of artificial joint. Accurate observation has, however, in a number of instances, established the occurrence of bony union after fracture of the surgical neck.

Treatment.—To reduce the fracture let an assistant fix the shoulder while another assistant makes the extension by seizing the middle of the forearm, bent at right angles, in one hand, and the wrist in the other; the surgeon will then endeavor to restore the displaced fragments to their normal position by pressure with his fingers. J. L. Petit directs the arm to be held at right angles with the body, while the extension is being made.

In those cases where there is little or no displacement of the frag-

ments, a simple sling for the forearm and a few turns of a roller, to confine the limb to the chest, will be all that is required.

In other instances, however, where they are constantly and obstinately disposed to assume an abnormal position, it will tax the surgeon's skill to the utmost to maintain the reduction with his apparatus.

Desault was in the habit of employing a bandage consisting of the following pieces: 1st. Two long rollers from two and a half to three inches wide. 2d. A wedge-shaped pad long enough to extend from the axilla to the elbow, and three or four inches thick at its base. 3d. Three splints from two and a half to three inches wide, two of which should be of the same length as the humerus, the third one shorter. 4th. A sling to support the forearm, and sufficiently long so as not to lift the arm. 5th. A towel to inclose the whole apparatus and chest.

In applying it, after the reduction has been effected, and an assistant still keeping up extension, the surgeon takes one of the rollers moistened in a dilute solution of the acetate of lead, to prevent its slipping, confines its initial extremity to the upper part of the forearm, and then, by circular and reverse turns, ascends the arm to the shoulder, over which the roller is passed to make two oblique turns under the sound axilla; the roller is then held by an assistant.

The first splint with its pad is placed upon the front of the arm extending between the bend of the elbow and the acromion; the second splint upon the outside of the arm, reaching from the external condyle to the acromion; and the third upon the back of the arm, reaching from the olecranon process to the margin of the axilla.

These splints are to be held in position by an assistant, while the surgeon takes the roller again and secures them by circular turns from above downwards.

The pad is now to be arranged in the axilla, and pinned to the arm-bandage, care being taken to place its base upwards if the fragments are displaced inwards, and exactly the reverse if they are pushed outwards.

The arm is then brought against the pad and secured to the chest by the second roller passing around the arm and chest, drawing its turns firmly below, and loosely above, if the fragments are displaced inwards, and the reverse in external displacement.

The forearm is placed in the sling, and the whole apparatus is enveloped in the towel.

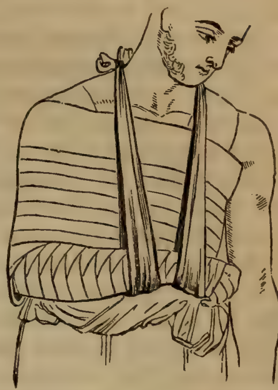
The method of Desault is a very good one, and in several parts of Europe is preferred to any other.

Sir A. Cooper recommends that a roller be applied from the elbow to the shoulder, splints to the outer and inner sides of the arm, and that these be confined by another roller. A cushion is placed in the axilla to throw the head of the humerus outwards, and the arm supported in a long sling, for, he says, if the elbow is raised, the bones will overlap and the union will be deformed.

Mr. Fergusson advises the bandages seen in Fig. 329, both for fracture of the surgical neck of the humerus, and for that of the tubercle and anatomical neck. It is applied by drawing down the lower fragment, and keeping the upper one in place by a small pad in the axilla;

a splint, about two inches and a half wide, reaching from the acromion to the elbow, is placed upon the outside of the arm and secured by a roller extending from the fingers to the shoulder. The arm is then brought to the side and confined to the chest by circular turns: the hand is supported in a sling.

Fig. 329.



Apparatus for fracture of surgical neck of the humerus.

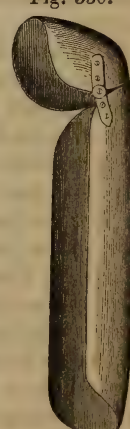
In order to prevent the bandage being deranged, when it is necessary to retain it a long time, he suggests that the roller be moistened with a thick solution of starch or dextrine before its application.

Mr. Erichsen, in managing these fractures of the upper extremity of the humerus, found a very convenient apparatus "to consist of a leathern splint about two feet long by six inches broad, bent upon itself in the middle, so that one-half of it may be applied lengthwise to the chest and the other half to the inside of the injured arm, the angle formed by the bend, which should be somewhat obtuse, being well pressed up into the axilla." In this way, he says, the tendency of the lower fragment to displacement inwards is corrected and the limb well steadied.

Welch's shoulder-splint (Fig. 330), or a splint prepared in the same form, of leather, gutta-percha, felt, or pasteboard, is also an excellent contrivance for maintaining the reduction, and it is the one I generally employ for this purpose.

In one case Mr. Tyrrell was obliged to keep the arm at right angles with the side, by means of a splint shaped like the letter L reversed.

Fig. 330.



Welch's shoulder-splint.

Richerand, to correct the inward displacement of the lower fragment, advised that the elbow be carried to the front of the chest, the hand reposing upon the sound shoulder; it is bound in this position by the roller-bandage after the manner of Velpeau's clavicle apparatus.

Dupuytren placed a wedge-shaped pad in the axilla with its base downwards and confined the arm to the side with a roller bandage.

5. *Fracture of the Body of the Humerus.*—The body of the humerus includes the space between the surgical neck and the condyles.

Causes.—The causes of this fracture are direct violence, counter-stroke from falls upon the elbow or hand, and muscular action.

The nature of the displacement will depend upon the seat of the injury; if it is above the insertion of the deltoid, the action of this muscle will draw the lower fragment upwards and outwards, while the upper piece will

be depressed towards the chest by the latissimus dorsi and pectoralis major.

When the fracture is below this point, the deltoid will draw the upper fragment outwards and a little forwards, and the lower one will be lifted by the biceps and triceps upwards and inwards, though in most cases the weight of the limb below will prevent the latter displacement in a great measure.

From the close connection of the triceps and brachialis anticus with the lower part of the humerus, a fracture in this portion will determine very little derangement of the fragments.

Symptoms.—Crepitus may be easily developed by moving the fragments; the limb will generally be shortened, the cases in which it will not be observed are those where the line of fracture is transverse; there will be preternatural mobility; and the patient will be unable to use the limb.

This fracture usually unites in six or seven weeks, with an average shortening of three-fourths of an inch, if it is an oblique one.

Treatment.—To accomplish the reduction let an assistant fix the shoulder by grasping it in his hands; the surgeon then takes hold of the arm and makes extension until the object is accomplished.

The ordinary retentive bandage for fracture of the body of the humerus is applied in the following manner: with a roller envelop the arm moderately from the fingers to the shoulder, making four or five circular turns at the point of fracture; take four padded splints of different lengths, one of which is to be placed upon the outside of the arm reaching from the acromion to the outer condyle, a second upon the inner side extending between the axilla and inner condyle, a third upon the posterior surface, and the last one upon the anterior. These splints are to be held by an assistant while the surgeon secures them either with the roller-bandage or with three strips of bandage tied around them at equal intervals.

The inner splint is, to some extent, objectionable, as it may exercise injurious pressure upon the axillary vessels and nerves. It can be easily discarded without impairing the efficiency of the apparatus, the support given to the bone by it, being sustained by moving the anterior and posterior splints near each other.

It has been suggested, to obviate this objection, to substitute for the inner splint an axillary pad; but this does not accomplish the purpose, as it too will exert pressure upon those parts.

Grooved splints are much more efficient than flat ones, and should always be used if they are attainable, inasmuch as they afford a more uniform support to the surface of the arm.

Mayor's apparatus consists of a wire frame extending from the shoulder to the elbow, and embracing two-thirds of the circumference of the arm. This splint is to be padded with cotton batting, and secured to the limb with three pieces of bandage tied around them at equal intervals.

Equally as efficient a splint may be made, in the same shape, of pasteboard, sole-leather, gutta-percha, wood, or tin.

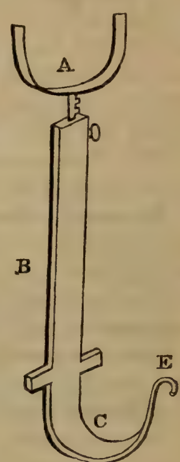
If the fracture is compound, that portion of the splint correspond-

ing with the injury may be removed, if it is required, to facilitate the application of the necessary dressings.

If the patient is confined to bed, permanent extension may be employed; if the ordinary apparatus fails, by adhesive strips attached to the limb and connected with cords which may be fastened to the head and foot of the bed.

Mr. Lonsdale used an apparatus for making extension, "consisting of a thin bar of iron, about an inch and a half wide, and long enough to extend from the axilla to the elbow, marked B in the wood-cut (Fig. 331). The lower end of the bar curves upwards underneath the elbow, so as to allow of this part of the limb fitting into it at C. This curve ends in a hook, E, for the attachment of a bandage; and on the splint opposite to this hook is a small bar, placed across the perpendicular, also for the attachment of a bandage. To the upper extremity of the splint a crutch is adapted, A, which fits underneath the axilla, and is movable up and down, being confined at pleasure by means of a small screw placed at the side of the vertical bar." It is placed upon the inner side of the arm, with the crutch in the axilla, and the elbow in its lower curved end, in which it is secured by a bandage passing about the hook and the little cross-piece opposite it.

Fig. 331.



Lonsdale's apparatus for fracture of the humerus.

The apparatus of Hind is superior to the instrument of Lonsdale, inasmuch as it supports the limb more effectually. It is composed of a metallic splint to be placed upon the inner side of the arm, divided into two sections moving in opposite directions by a screw, and supporting at its upper extremity a crutch to rest in the axilla. The splint is movably articulated to a padded metallic gutter, to inclose the forearm. By this arrangement the arm can be sustained at any angle of flexion. The apparatus is secured to the limb by four straps—two above, to encircle the arm; and two below, for the forearm.

The "immovable apparatus," prepared with plaster, pasteboard, or starched bandages, and already fully described, will also, in some of these cases of fracture, be found to be an exceedingly elegant and efficient contrivance.

6. *Fracture of the Humerus through the Base of the Condyles.*—This injury is produced by falls upon the elbow. The position of this fracture, which is generally oblique, is seen in Fig. 332.

Symptoms.—The arm will be found semi-flexed and shortened; there is a preternatural mobility just above the elbow; the olecranon projects posteriorly; a hard tumor is formed in the bend of the elbow by the projection of the lower end of the upper fragment; there will be an increase in the antero-posterior diameter of the elbow-joint; and crepitus may be easily developed by moving the fragments.

Diagnosis.—From the proximity of this fracture to the joint, it may be confounded with dislocation of both bones backwards. The main

Fig. 332.

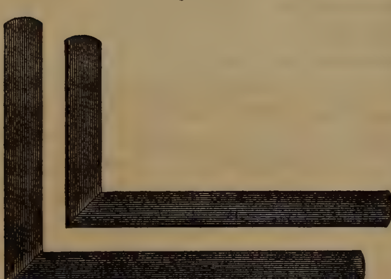
Fracture at the base of the condyles.

features of the two injuries will be found contrasted in the following table:—

Fracture.		Dislocation.
Falls upon the elbow.	*Cause.*	Falls upon the palms of the hands with arms extended.
Preternatural.	*Mobility.*	Much decreased.
Present.	*Crepitus.*	Absent.
Easy by extension, bones becoming again displaced when it is removed.	*Reduction.*	More difficult, bones not disposed to become displaced after reduction.
Diminished.	*Length of humerus, measured between condyle and acromion.*	Not diminished.
Unchanged.	*Relation of apex of the olecranon with the condyles.*	It is much above.
Prominence of the elbow increased by extension of the forearm.	*Prominence of the elbow.*	Prominence of the elbow diminished by extension of the forearm.
Tumor formed by lower end of upper fragment in the bend of the arm not large, and above the fold of the elbow.	*Tumor in bend of the elbow.*	Tumor very prominent, and below the fold of the elbow.

Prognosis.—Union occurs in from seven to eight weeks, commonly with some shortening, from a half to three-quarters of an inch. After the removal of the apparatus, the functions of the elbow will not be fully restored until after the lapse of several months.

Fig. 333.



Physick s elbow-splints.

Treatment.—The reduction of the fracture is effected by extension and counter-extension in the manner pointed out above.

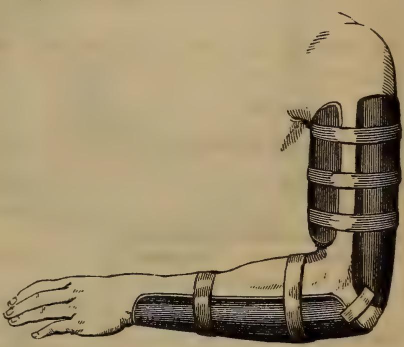
For the purpose of maintaining the fragments immovable, the late Dr. Physick recommended two angular splints (Fig. 333), which keep the forearm flexed at right angles.

In applying the apparatus, the fracture is to be reduced, and a roller put on the limb from the hand to the shoulder; the splints are padded, laid on the limb, and secured in position by the roller passing around them from above downwards.

These splints may be made of wood or pasteboard, and should be an inch and a half wide, the part applied to the arm extending from near the shoulder to the elbow, and that to the forearm from the elbow to the ends of the fingers, so as to prevent any motion in the hand; a handkerchief, passing around the neck as a sling, supports the weight of the forearm.

Sir A. Cooper, in treating this injury, directs the arm to be bent and drawn forwards to effect replacement; "and then a roller should be applied while it is in the bent position. The best splint for it is one formed at right angles, the upper portion of which is to be placed behind the upper arm, and the lower portion under the forearm; a splint must also be placed upon the forepart of the upper arm, and straps to confine both; and the arm kept in a bent position by a sling (Fig. 334).

Fig. 334.

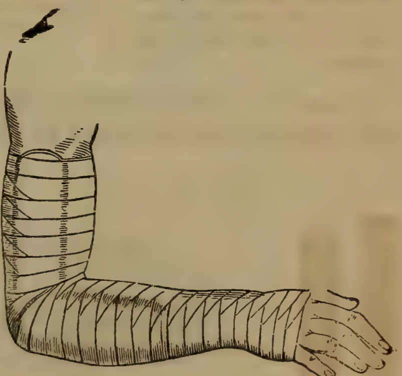


Sir A. Cooper's splint for fracture of humerus.

"In a fortnight, if the patient be young, passive motion may be gently begun to prevent the occurrence of anchylosis; and in the adult, at the end of three weeks, a similar treatment is to be pursued."

Mr. Fergusson advises that a piece of pasteboard, gutta-percha, or strong bend-leather, of the shape similar to that shown in Fig. 335, should be applied on one surface of the elbow, another of a like kind on the opposite, and both should be retained with a bandage, which should extend as here exhibited, from the hand to the middle of the arm. The splint for the inner side should have a round hole or deep hollow opposite the condyle, so that it may fit all the better without injurious pressure. Sometimes, if bandages are thus applied, it will be found that the fingers become œdematous, when they also may be enveloped in narrow rollers.

Fig. 335.



Fergusson's mode of treating fracture above the condyles.

Dr. Hamilton prepares an apparatus for this injury by moulding to the shoulder, arm, and forearm,

Fig. 336.

Hamilton's elbow splint.

as far as the base of the fingers, a sheet of gutta-percha, as seen in Fig. 336.

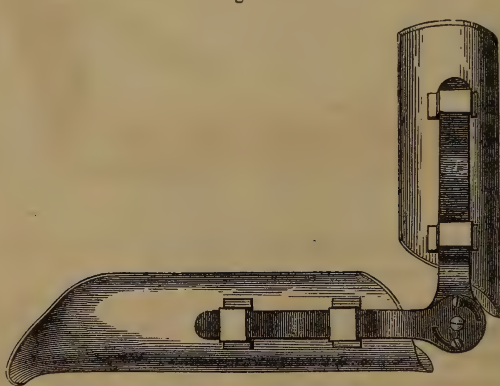
In applying the splint, pad it neatly with cotton-batting so as to make the pressure uniform everywhere, put it on the limb, and secure it in position by a roller bandage.

As early as the eighth day he directs that the arm be removed from the splint and gentle passive motion imposed upon the joint, to prevent anchylosis; this must be repeated as often as every second or third day.

In the construction of the foregoing apparatus, the arm and forearm splints are immovably connected at the elbow. There are others in which provision is made for obtaining motion at the elbow-joint. Of these the one I prefer to all others, and which, in my opinion, possesses all the advantages derivable for an elbow splint is that of Dr. Bond. It consists of two metallic gutters, one for the arm and the other for the forearm, connected together upon one side by a lateral bar of iron jointed at the elbow; the motions of the joint being controlled by a screw.

As seen in Fig. 337, the bar is connected with the gutters in such a

Fig. 337.



Bond's elbow splint.

manner that the former may be removed at pleasure, and adapted to gutters of any size.

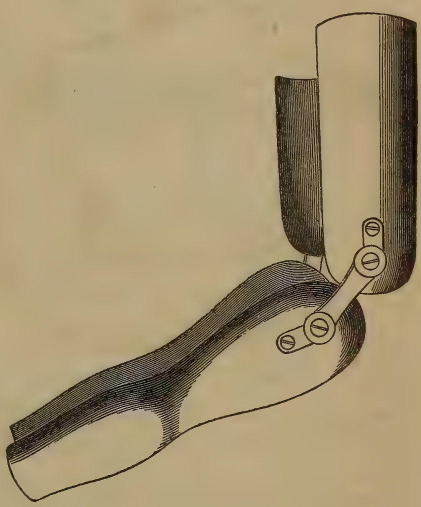
In using the apparatus, the splint must be padded with cotton-

batting, and the arm laid upon it; then apply a roller bandage from below upwards.

At the end of seven or eight days, by simply loosening the screw at the elbow, passive motion may be imposed upon the joint without disturbing the apparatus in the least.

The apparatus of Welch (Fig. 338) is made in a similar manner to that of Bond's, gutta-percha being substituted for metal in making the splints. The metallic joints may be removed at will, and put upon other splints.

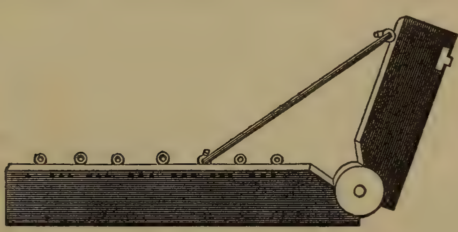
Fig. 338.



Welch's elbow splint.

Dr. Kirkbride's elbow splint consists of two short splints connected at the elbow by a hinge. The arrangement for checking the joint movement is formed of a swivel eye passing through the top of the splint, riveted upon its posterior edge, and a row of metallic eyes, two inches apart, between which there are series of small holes in the wood upon its anterior edge; by means of a wire connected with the swivel eye above, and hooked in the eyes and holes below, the arm may be bent to any angle (Fig. 339).

Fig. 339.



Kirkbride's elbow splint.

This splint is to be padded and applied upon either the inner or outer side of the limb with a roller bandage.

The splints of Rose and Day are constructed in the manner seen in Figs. 340 and 341. They are made of wood, and carved in the shape of the surface of the limb; they are much less convenient and efficient than the apparatus described previously.

In compound fracture near the elbow I have, in several instances, used the apparatus recommended by Mayo with advantage (Fig. 342). It consists of "two splints joined together by two small bars so as to

Fig. 340.

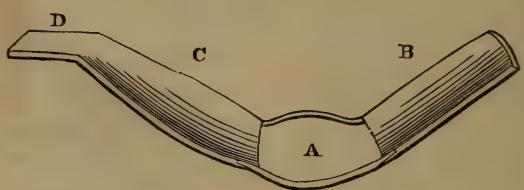
Rose's splint.

Fig. 341.

Day's splint.

leave a space between them for the elbow to fit into. One of the splints, B, seen in the wood-cut, is made for the back part of the arm

Fig. 342.



Mayo's apparatus for fracture.

to lie upon, while the other, C, is for the forearm; the second splint terminates in a horizontal portion, D, for the hand to rest upon; the intervening space, A, is formed by the two lateral bars, which are slightly curved outwards, to prevent pressure upon the joint.

7. *Fracture through the Lower Epiphysis of the Radius.*—Dr. Robert Smith, of Dublin, describes a fracture occurring in young persons before the ossification of the lower epiphyseal centres to the shaft of the humerus has taken place, which differs from the supra-condyloid fracture in that the line of separation runs below the condyles, which properly belong to the diaphysis of the bone.

He remarks that "the symptoms which belong to it in common with fracture above the condyles are the following: Shortening, crepitus, the removal of the deformity by extension, and its tendency to recur when the extending force is relaxed; the presence of an osseous tumor in front of the joint; the increase in the antero-posterior direction of the elbow.

"It differs from supra-condyloid fracture in the greater transverse breadth and regular convex outline of the anterior tumor; in the existence of two tumors posteriorly; in the loss of the normal relation of the olecranon to the condyles.

"It resembles dislocation of both bones of the forearm backwards, in the following particulars:—

"The transverse diameter of the anterior tumor is the same in each

case; so also is the antero-posterior breadth of the elbow; and in both the olecranon ascends above the condyles, the limb is shortened, and two osseous prominences can be distinguished posteriorly. It differs, however, from luxation in the existence of crepitus, the tendency of the deformity to recur, in the anterior tumor being destitute of trochlea and capitulum, and in the circumstance of the two posterior tumors being nearly upon the same level."

8. *Fracture through the Base of the Condyles with a Fracture running between them into the Joint.*—This variety of fracture is seen in Fig. 343. It is caused by falls and blows upon the elbow.

Fig. 343.

Fracture at the base of and between the condyles.

Symptoms.—The arm will be shortened; the elbow increased in width; ulna and radius displaced backwards and upwards; preternatural mobility; and crepitus may be elicited when the ulna is drawn down into place, and the condyles are rubbed against each other.

Treatment.—Whatever method of treatment may be pursued in this fracture, anchylosis will be almost sure to follow.

I have an interesting specimen of this fracture which I obtained from an arm amputated one year after the injury. The joint was anchylosed, and there was a complete abolition of sensation and motion below the point injured.

The line of fracture is exactly transverse; the external condyle with the portion of trochlea attached is displaced backwards so that its anterior border corresponds with a line running across the middle of the lower surface of the upper fragment. The internal condyle, with that part of the trochlea connected with it, is displaced upwards, its external edge lying beneath the inner edge of the external fragment, and united to the shaft of the humerus.

The surgeon ought to replace the fragments as well as he can by having the limb extended, while with the fingers he presses them into their natural position. One of the elbow splints above described may then be applied.

Fig. 344.

Fracture of the external condyle.

Desault recommends an apparatus which consists of two angular splints, one for each side of the arm, and two others for its anterior and posterior surfaces. These are to be accurately moulded to the elbow, then padded and secured to the arm with a roller bandage.

9. *Fracture through the External Condyle.*—In fracture of the external condyle the line of separation passes from the external condyloid ridge beyond the capsular ligament downwards and inwards into the joint, as seen in Fig. 344.

This injury is generally met with in children, and results from blows or falls upon the elbow.

There will not usually be found much displacement of the fragment, in consequence of the support given to it by the surrounding muscular fibres; there are cases, however, in which the condyle is displaced backwards, carrying along with it the head of the radius.

Symptoms.—Pain in the movements of flexion and extension; prominence of the fractured condyle; crepitus developed by rotating the forearm; and when the forearm is extended, it is sometimes deflected towards its radial margin.

Treatment.—Place the forearm at right angles with the arm, and apply one of the rectangular splints already described. It may be necessary, in rare cases, in order to keep the condyle in its normal position, to adopt the extended posture for the limb. At the end of seven or eight days remove the splint, and exercise the joint gently every two or three days.

Whatever treatment is pursued, anchylosis will be often found following the injury.

10. *Fracture through the Internal Condyle.*—This variety of fracture is met with almost exclusively in childhood. It is caused by falls upon the point of the elbow. The line of fracture passes usually from a point about half an inch above the epicondyle outwards into the joint, as seen in Fig. 345. The fragment is generally displaced upwards, backwards, and a little inwards, though it may occur forwards and inwards. I have a specimen in which the displacement has taken place directly upwards.

Fig. 345.

Fracture of the internal condyle.

Symptoms.—The ulna being carried backwards with the condyle it will cause a projection of the olecranon when the forearm is extended; the prominence disappearing again in flexing the limb. In extension also the end of the humerus will form a tumor in the bend of the elbow. If the finger be put on the condyle, by flexing and extending the forearm, crepitus will be perceived.

Treatment.—This fracture should be treated in the same manner as that of the outer condyle. The elbow should be inspected every day so as to watch the progress of the case, and to correct any undue or hurtful pressure upon the part.

At the end of a week remove the splint, and begin to impose passive motion upon the joint, and repeat it every two or three days.

As in the previous variety of fracture, anchylosis will often attend the best conducted treatment.

11. *Fracture through the Internal Epicondyle.*—The little projection upon the inner condyle, called the epicondyle, may be broken by falls upon the inner side of the elbow.

I saw a case with Dr. Stone, of Washington, in a boy fourteen years of age, who fell from a cart to the ground, striking upon the inner side of the elbow, where the skin was a little bruised; the epicondyle was displaced somewhat upward. The compress was placed above the displaced fragment, which could easily be brought down,

and confined by a figure of 8 bandage; the arm was then placed in a rectangular splint of pasteboard.

In seven days the splint was removed, and the joint exercised; the treatment was continued for a few days longer, when the apparatus was entirely abandoned; the boy recovered with all the functions of the limb intact.

In most of the recorded cases of this injury the displacement of the fragment has been downwards.

It will be proper to add here, that the treatment recommended in the above sections for fracture of the condyles is different from that pursued and recommended by Dr. Warren, of Boston, who says that "in the treatment of fractures of the condyles of the os humeri, a course is usually recommended which he believes to be hurtful, inasmuch as it favors the worst consequences of the injury, namely, loss of motion in the joint. By this mode of treatment, the fractured piece becomes sufficiently fixed to create partial anchylosis; and there is so much pain afterwards in the proposed passive movements as to cause the omission of these measures until permanent stiffness takes place. The proper course in the management of these accidents, he conceives to be: 1st. To apply no splints, but in the earlier days to make use of the proper means to prevent inflammation. 2d. To accustom the patient to early and daily movements of flexion and extension. 3d. When the action of the joint becomes limited, to overcome the resistance by force, and repeat it daily until the tendency of the joint to stiffen ceases."

FRACTURE OF THE RADIUS AND ULNA (Fig. 346). *Causes.*—Fracture of both the radius and ulna results from direct blows upon the forearm, and from indirect force, the patient falling upon the palms of the hands, with the arms thrown forward.

Fig. 346.

Fracture in the lower third.

The fracture may be simple or comminuted, or compound, and is usually seated in the middle and lower thirds of the bones. The upper part of the ulna is stouter than it is elsewhere, and is covered with a thick layer of muscles, which amply protects it. These circumstances explain the rarity of fracture in the upper third of the bone.

Both bones are commonly broken at or near the same level, though the reverse may occur. The fragments may be displaced in any direction; that most often observed is where they are pushed either to the radial or ulnar side of the forearm; they also may sometimes approximate each other. There can occur but little displacement in the direction of the length of the bones in consequence of the connection of the interosseous ligament to their inner borders.

Symptoms.—The symptoms are inability to pronate and supinate the forearm; preternatural mobility; deformity at the seat of fracture; and crepitus by pressing the fragments in opposite directions.

Prognosis.—In simple fracture of both bones, and

under proper treatment, union will take place between three and five weeks, without apparent deformity.

It may, however, be delayed in rare cases for months, or even may not take place at all. Sometimes it happens that one or the other bone unites promptly in the usual time, while union in the other is delayed.

Improper dressings can destroy the functions of pronation and supination by pressing the radius and ulna together while the consolidation is being effected.

Treatment.—The reduction is accomplished by making extension and counter-extension from the wrist and elbow, while the surgeon presses with his fingers upon the front and back of the forearm, over the interosseous space, so as to force the bones asunder.

In applying the retentive apparatus it was formerly the custom to put a bandage upon the limb from the hand to the shoulder before the splints were laid on. It is now very properly discarded, inasmuch as the practice effected exactly what the surgeon endeavors to prevent—a drawing together of the radius and ulna.

The ordinary apparatus consists of two flat splints of greater width than the forearm, and padded in such a manner that they may be a little thicker along the centre than at the margins; they should be of unequal length, the anterior reaching from the bend of the elbow to the tips of the fingers; and the posterior, from the elbow to the roots of the fingers. These splints are laid upon the forearm, and confined by a roller bandage. The arm ought to be examined every day, to be sure that no injurious pressure is exercised at any point.

Some surgeons, instead of padding the splint, employ graduated compresses beneath them in order to force the muscles towards the interval separating the bones. In this case, as suggested by Nélaton, the compresses ought to be short, so as not to press upon the ulna and radial arteries.

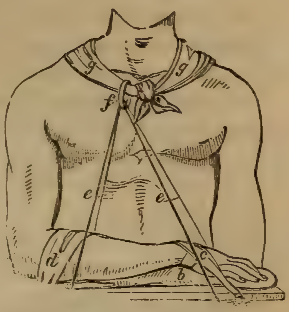
When the splints have been properly secured to the forearm it will be advisable, if it is possible, to put the forearm in a posture of supination, and projecting in front of the body, while the elbow rests against the side. In this position the fragments will be more easily brought together, and the bones will encroach less upon the interosseous space, thus rendering any impairment of the function of supination, when consolidation occurs, much less likely to follow; there will also be less tendency to lateral distortion.

Although these advantages are manifest, yet there are some surgeons who have overlooked them, and directed the forearm to be placed midway between supination and pronation, with the plane of the hand vertical.

In compound fractures it may be necessary to put the forearm in a posture of pronation; in such cases the limb may be laid upon a simple flat board, and loosely connected to it, above and below, by a few turns of a roller.

If the person is able to walk about, the apparatus of Mayor may be employed, which consists of a board a little longer than the forearm

Fig. 347.



Mayor's apparatus for fracture of the forearm.

and hand, a cushion, a cord for suspension, and three cravats. "The fracture being reduced, the forearm is placed upon the cushioned boards *a, b* (Fig. 347), which is immediately suspended from the patient's neck by means of the arc-loops *e, e*, the ring *f*, and the cervical cravat *g*. The second cravat, *c*, is now placed under the wrist, and crossed upon the back of the hand, the tails being then made to embrace the cushioned board, and knotted at the anterior border, as represented at *h*. The third cravat is made to pass around the apparatus at its upper part, so as to confine the corresponding portion of the forearm, and is then knotted as the other. If it be necessary to counteract any lateral displacement, a fourth cravat may be made use of, to serve as a traction ligature; which will of course be knotted at the inner margin of the suspension-board."

If the patient be confined to bed, the apparatus may be supported by a cord hanging from the ceiling, or from an upright fastened to the bedstead.

FRACTURE OF THE RADIUS.—Fracture of the radius is more frequent than that of both bones of the forearm, or of the ulna alone, and the right is more often broken than the left.

There are three varieties of this fracture which we shall consider separately. 1st. Fracture of the upper extremity. 2d. Fracture of the shaft. 3d. Fracture of the lower extremity.

1. *Fracture of the Upper Extremity of the Radius. Causes.*—Fracture of the upper extremity of the radius is the least frequent of the three varieties, and is produced by direct blows upon the part, and by counter-stroke.

The line of fracture may be above or below the insertion of the biceps muscle.

Symptoms.—In fracture through the neck of the radius, which is exceedingly rare, the biceps will draw the superior end of the lower fragment upwards, forwards, and inwards, while the supinator radii brevis will displace the head slightly outwards, perhaps, forming a prominence in front of the elbow; there will be loss of voluntary supination and pronation; if the surgeon grasps the elbow in his left hand pressing with the thumb upon the head of the radius, the latter will not be found to move when he supinates and pronates the forearm with his right; the hand will be found in a prone position, and crepitus will be perceived during the movements executed in the examination.

If there is much tumefaction, the diagnosis will be exceedingly difficult, if not impracticable.

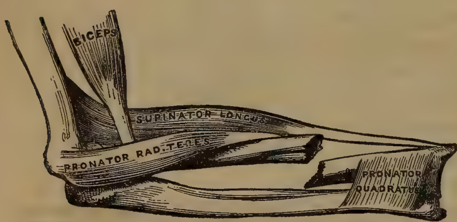
Treatment.—Bend the forearm at right angles to relax the biceps, place a rectangular splint upon the posterior surface of the limb, and a compress in the bend of the elbow, and then confine the whole with a roller bandage; support the arm in a sling.

2. *Fracture of the Shaft of the Radius.*—Fracture of the shaft of the radius occurs most frequently in its lower third.

Causes.—Direct injury to the bone, and by falls upon the palms or backs of the hand when the arm is stretched forward.

The displacement of the fragments that occur will depend in a great measure upon the nature and direction of the force. They may both be depressed towards the ulna, or be thrown forwards, backwards, or outwards.

Fig. 348.



Fracture of the shaft of the radius.

The Fig. 348 shows the upper fragment displaced forwards by the action of the biceps and pronator radii teres, while the lower one is drawn towards the ulna by the pronator quadratus, and supinator longus.

Treatment.—The splints required in the treatment of this fracture are the same as those described for fracture of both bones.

3. *Fracture of the Lower Extremity of the Radius.*—Fracture of the lower extremity of the radius occurs most frequently within an inch and a half of the articulating surface, and constitutes what is known as "Colles' fracture."

The line of separation is generally horizontal, though it may be oblique from above downwards and from behind forwards, or the reverse.

In the injury known under the name of "Barton's fracture" this line runs upwards and backwards from the joint, separating a greater or less extent of the articulating surface of the radius from the shaft.

Cause.—This fracture always results from falls upon the palm or back of the hand while the arm is outstretched.

Symptoms.—The characteristic appearance of this injury is seen in Fig. 349. The lower fragment of the radius is carried backwards, upwards, and outwards by the extensors of the thumb and the supinator longus displacing the carpus and metacarpus in that direction, and forms a tumor upon the back of the wrist; above this there is a well-marked depression. In front another prominence is observed extending about one-third up the forearm; the hand falls towards its radial margin, while the styloid process of the ulna projects prominently in

Fig. 349.

Fracture of the radius near its lower end.

the direction of the palm; by grasping the hand and moving it, crepitus may be made manifest.

Treatment.—The reduction of the fracture is accomplished by making extension from the hand, and at the same time exercising pressure upon the tumor at the back of the wrist from behind forwards.

The indication to fulfil in the use of apparatus is manifest, namely, to incline the hand to the ulnar border of the forearm and retain it in that position.

For this purpose Dupuytren recommended a splint made of a bar of iron (Fig. 350), about an inch wide and of the length of the forearm, and which, at its lower extremity, opposite the part corresponding with the wrist, curves downwards in a semi-circle, to the concavity of which some buttons are placed at equal distances.

Fig. 350.

Dupuytren's apparatus for fracture of the radius near the wrist.

To apply the splint, place beneath it upon the ulnar border of the forearm a narrow pad, extending from the styloid process of the ulna to the elbow, and about one inch thick below, gradually tapering upwards; then with a roller secure it to the limb; arriving at the wrist make turns around the radial border of the hand and curved extremity of the splint, so as to maintain the hand in a position of forced adduction.

Sir A. Cooper, in treating this fracture, applied a roller from the wrist to the elbow, and then two padded splints upon the anterior and posterior surfaces of the forearm, reaching from the elbow to the roots of the fingers; the splints were secured to the limb by a second roller, beginning at the wrist. The forearm is now placed in a sling in a position midway between pronation and supination, so that the weight of the hand, moving freely between the splints, may adduct it.

The method pursued by Nélaton was to apply a pistol-shaped splint (Fig. 351), well padded, to the dorsal surface of the forearm, reaching

Fig. 351.

Nélaton's splint for racture of the radius.

from the tips of the fingers to the elbow, and a straight one upon its

palmar surface extending from the wrist to the elbow; a compress is to be placed beneath the curved splint and over the lower fragment, while the straight splint must be placed opposite the upper fragment, and also along its radial margin, to prevent the tendency which this part of the radius has to pronation. The splints are secured to the arm with a roller bandage.

Another plan, recommended by this distinguished surgeon, is the following: Place a square compress over the lower fragment at the back of the forearm, and a long compress upon its palmar surface reaching from the elbow to a point just above the lower margin of the prominence upon that side. Upon these compresses lay two straight splints extending from the wrist to the elbow, and confine them by a roller bandage or three broad strips of adhesive plaster; the hand is thus left free to take a position of adduction by its own weight, while the compresses force the fragments in directions opposite those of their displacement.

The splint devised by Dr. Bond, of Philadelphia, is also an efficient one in the treatment of this injury; it is prepared in the following manner: Cut from any sort of light wood a splint having the shape of that seen in Fig. 352, and long enough to extend from the elbow

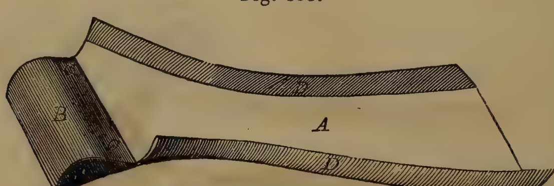
Fig. 352.

Bond's splint for fractured radius.

to the second joints of the fingers. To its lower extremity fasten with screws or nails a cylindrical piece of wood *B*, which is intended to support the palm when the forearm reposes on the splint.

To make it more comfortable narrow strips (*D*) of binders' board or leather may be nailed to the lateral edges of the splint, Fig. 353.

Fig. 353.

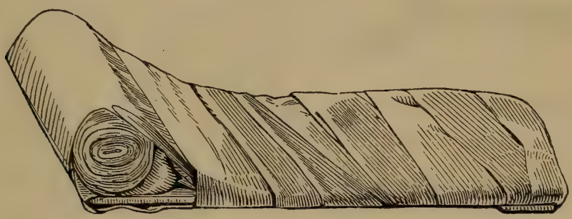


Bond's splint with strips attached.

The apparatus is applied by padding the splint with cotton-batting or flannel, and laying the forearm with the fracture reduced upon it; above and below the point of injury, a compress of suitable thickness is to be placed, and then the whole dressing inclosed with a roller bandage.

Should the elegant splint of Dr. Bond not be attainable, one some what similar in form may be prepared as directed by Dr. Hays, from any sort of wood that may be at hand; it is cut into the shape seen in Fig. 354. As a substitute for the cylindrical piece of wood, a

Fig. 354.

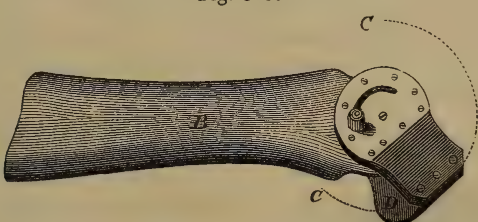


Hays' splint for fracture of radius.

common roller can be used, secured to the end of the splint by a bandage, as shown in the cut.

Dr. E. P. Smith has modified Bond's splint in such a manner that one splint may be employed upon either arm. This object is attained by articulating the palm-block *D* (Fig. 355) with the guttered arm-

Fig. 355.

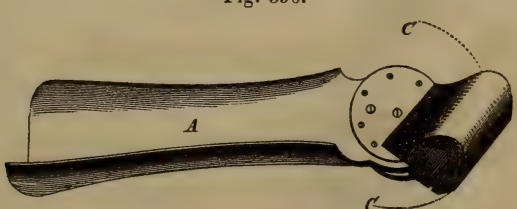


Smith's modification of Bond's splint. Back view.

splint *A*, by means of a circular joint which may be fixed at any angle by a thumb-screw placed upon its posterior surface.

The range of motion of the palm-block is indicated in Fig. 356 by the dotted arc *C C*.

Fig. 356.

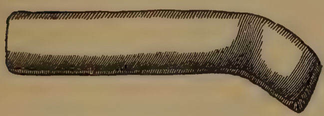


Same splint. Front view.

The apparatus employed by Dr. Hamilton is directed to be prepared extemporaneously from a wooden shingle, cut into the requisite

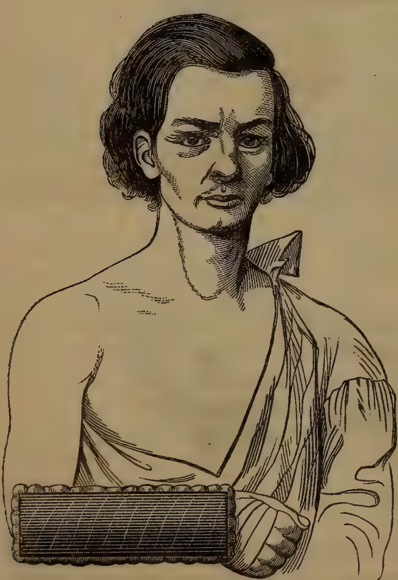
shape and length (Fig. 357), the length being obtained by measuring from the front of the elbow-joint, when the arm is flexed to a right angle, to the metacarpo-phalangeal articulations. It ought, indeed, to fall half an inch short of the bend of the elbow, to render it certain that it shall make no uncomfortable pressure at this point; and the direction to measure with the arm flexed is of sufficient importance to warrant a repetition. The breadth of the splint should be, in all its extent, just equal to the breadth of the forearm in its widest part, so that there shall be no lateral pressure upon the bones. If the splint is of unequal breadth, the roller cannot be so neatly applied, and is more likely to become disarranged. Thus constructed, it is to be covered with a sack of cotton cloth, made to fit lightly, with the seam along its back, and afterwards stuffed with cotton-batting or with curled hair. These materials may be passed in and easily adjusted, whenever they are most needed, from the open extremities of the sack. While preparing, the splint must be occasionally applied to the arm until it fits accurately every part of the forearm and hand, only that the stuffing must be rather more firm a little above the lower end of the upper fragment. The open ends of the sac are then to be neatly stitched over the ends of the splint. This splint is now to be laid directly upon the skin without any intermediate compresses or rollers. In all cases it is better to employ, also, at least during the first fortnight, a straight dorsal splint, of the same breadth as the palmar splint, and of sufficient length to extend from the elbow to the middle of the metacarpus (Fig. 358). This should be covered and stuffed in the same manner as the palmar splint, except that here the thickest and firmest part of the splint must be opposite the carpus, and the lower end of the lower fragment. It will answer the indications also a little more completely if, at this point, the padding is thicker on the radial than on the ulnar side. The application of the apparatus is effected by restoring the fragments to place, in case of Colles' fracture, by pressing forcibly upon the back of the lower fragment, the force being applied near the styloid apophysis of the radius, the arm

Fig. 357.



Hamilton's splint for fracture of the radius.

Fig. 358.



Apparatus applied.

is to be flexed upon the body, and placed in a position of semi-pronation, when the splints are to be applied and secured with a sufficient number of turns of the roller, taking especial care not to include the thumb, the forcible confinement of which is always painful and never useful.

Dr. J. Rhea Barton recommended the application of two broad, straight, and padded splints to the dorsal and palmar aspects of the forearm, extending from the elbow to the tips of the fingers; beneath the splints two compresses are placed, one over the posterior surface of the lower fragment, the other over the anterior surface of the upper one; a roller bandage is used to secure the splint to the forearm.

Colles also used straight splints.

Prof. Fauger, of Copenhagen, discarding all sorts of splints in the treatment of this injury, advises the forearm to be laid upon a wedge-shaped support, inclining towards the patient, with the hand hanging over the perpendicular end or base of the support.

Fracture of the Ulna.—The varieties of fracture of the ulna may be described under the following heads: 1st. Fracture of the olecranon process. 2d. Fracture of the coronoid process. 3d. Fracture of the body and lower extremity.

1. *Fracture of the Olecranon Process. Causes.*—Fracture of the olecranon process is generally caused by falls upon the point of the elbow, or by direct blows; it is also occasionally seen to result from violent contraction of the triceps.

The line of fracture may pass through any point of the process from the base to the apex, but it generally occurs midway between these points. Its direction is commonly transverse, occasionally oblique, either from before downwards and backwards, or from above downwards, and from behind forwards.

Fig. 359.

Fracture of the olecranon process.

The olecranon is displaced upwards, or in the direction of the line of action of the triceps, producing an interval between it and the ulna from a few lines to two inches according to the extent of the laceration of the tendinous insertion of that muscle.

Symptoms.—The limb will be in a posture of semi-flexion, and the patient will be unable either to flex or to extend it. A depression will be observed above the point of the elbow caused by the absence of the olecranon and the tendon inserted into it; that process can be felt drawn up into its new position. If the arm is extended, the olecranon may be easily brought down, and, by rubbing it laterally against the ulna, crepitus will be perceived. To these symptoms are to be added pain and swelling at the seat of injury.

Prognosis.—If the fragment is kept in contact with the ulna, bony union may occur, but in the majority of cases the cure is brought about by ligamentous union.

Treatment.—Extend the forearm to relax the triceps, bring down the olecranon, and secure it in apposition with the ulna by an appropriate apparatus.

The method pursued by Sir A. Cooper was "to place a piece of linen longitudinally on each side of the joint; a wetted roller is applied

Fig. 360.

Sir A Cooper's apparatus for fracture of the olecranon.

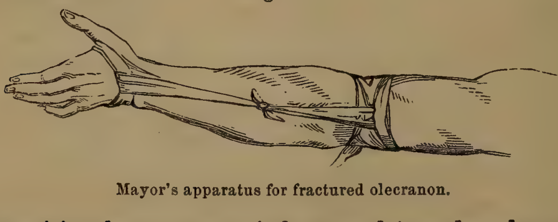
above the elbow, and another below it; the extremities of the linen are then to be doubled down over the rollers and tightly tied, so as to cause an approximation of the fragment; thus the portions of bone are brought and held together; a splint well padded is to be applied upon the forepart of the arm to preserve it in a straight position, and confined to it by a circular bandage."

If there is much inflammation before applying this apparatus, it will be necessary to have recourse to leeches and cold water-dressings for two or three days.

The apparatus of Mr. Amesbury consists of two belts, one fastened above the olecranon, and the other upon the forearm, which he connected together by lateral straps and buckles to draw the upper fragment down; upon the anterior surface of the arm a guttered splint is to be applied to keep the limb fully extended.

In an emergency, the plan recommended by M. Mayor may be pursued: The arm is placed in an extended position; to its anterior surface a pasteboard splint is moulded (or a splint of any other sort may be used if the pasteboard is not at hand), extending from about three inches above the elbow to the tips of the fingers; the olecranon is now brought in contact with the ulna, and above it is placed a compress,

Fig. 361.



Mayor's apparatus for fractured olecranon.

secured in position by a cravat tied around it and under the arm, the tails of the cravat being permitted to hang towards the hand upon the back of the forearm; another cravat is tied around the lower part of the splint and the metacarpus, when the tails of the two cravats are knotted together posteriorly at the middle of the forearm.

Desault objects to placing the arm in an extended position (an objection concurred in by both Velpeau and Nélaton), and recommends

that the forearm be kept midway between semiflexion and complete extension by an angular splint. The reason assigned is, that in fracture of the olecranon at its base the extended position causes the brachialis anticus to draw the upper end of the ulna somewhat forwards, so that the fragments cannot be kept in a straight line; and if union should occur under these circumstances, it will be at their posterior edges only, thus forming an open angle opposite the joint into which the substance effused for uniting the fracture will be thrown, and by its subsequent organization impede the motions of the elbow.

After the splints have remained on the limb for three weeks they must be removed, and passive motion impressed upon the joint to prevent anchylosis.

2. *Fracture of the Coronoid Process.*—Fracture of the coronoid process of the ulna is seen in Fig. 362. It is of extremely rare occurrence; so much so, indeed, that there are but few unquestionable instances of the kind upon record.

Fig. 362.

Fracture of the coronoid process.

M. Kühnholtz, of Montpellier, describes two varieties of the injury, the first consists in the simple knocking off of the top of the process either by direct force, or what is more frequent, by falls upon the palms with the arms thrown forward, the weight of the body being chiefly sustained upon the hypothenar margin of the hand. The injury is recognized by the inability of the patient to flex the arm until the reduction is effected, which is very difficult; by the presence of a small, hard, and freely movable body in front of the joint; and lastly, by a sudden cracking felt by the person in the bend of the elbow at the moment of the fall.

The second variety involves the base of the process, and is always produced by direct violence, and is generally accompanied by a dislocation backwards of the ulna, or a fracture of one or both of the bones of the forearm, and so much laceration of the soft parts that amputation is often required.

Fracture of this process cannot result from muscular action, inasmuch as there are no fibres inserted into it that could exercise the required amount of force to effect it. The brachialis anticus is inserted at its base.

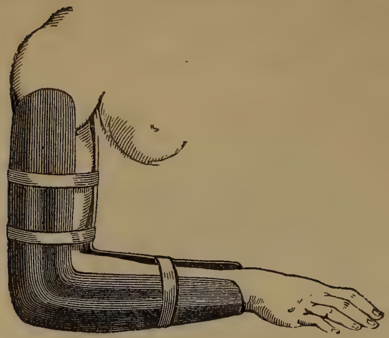
Treatment.—Flex the forearm at right angles, and mould to the posterior surface of the limb a splint of gutta-percha, pasteboard, or plaster of Paris; place a compress upon the fold of the arm, and then inclose the apparatus in a roller bandage from the hand upwards.

At the expiration of the third week the splint should be removed and the elbow gently exercised daily to prevent the occurrence of anchylosis.

3. *Fracture of the Shaft and Lower Extremity of the Ulna.*—The body of the ulna is most frequently broken at its lower third in an

28

Fig. 363.



Apparatus for fracture of the coronoid process.

Fig. 364.

Fracture of the shaft of the ulna.

oblique direction, as seen in Fig. 364. It is commonly caused by a blow or fall upon the ulnar border of the forearm; a fall upon the palm of the hand may also produce it.

Symptoms.—The upper extremity of the bone will be held in position by its connections at the elbow, while the lower one will be drawn by the pronator quadratus outwards, or towards the radius, causing a depression upon the ulnar border of the forearm that may be easily seen and felt; crepitus may be elicited by rubbing the ends of the bones together in opposite directions. In some cases the displacement of the lower fragment deflects the hand to the ulnar side of the axis of the forearm.

Treatment.—If there exist displacement of the fragments, it must be corrected by making moderate extension upon the hand, while the bones of the forearm are forced asunder by pressure exercised with the fingers, otherwise they will become joined together by osseous union and the functions of pronation and supination will be destroyed.

After the bones have been restored to their proper position the limb may be put upon a splint, similar in construction to that of Bond, with the difference that its lower end must curve in the opposite direction, so that the hand may be held in a position of abduction, to throw the upper end of the lower fragment away from the radius.

Fracture of the Carpus.—Fracture of the bones of the wrist is always the result of direct and great violence, which commonly lacerates the soft tissues to such a degree as to frequently necessitate amputation.

Treatment.—As there will be much inflammation in these cases, it is advisable to simply put the hand upon a broad board in the most convenient posture for the application of the needed dressings, and to facilitate the escape of any pus that may happen to accumulate.

When the inflammatory action has been quelled by appropriate remedies, and the soft tissues healed, the wrist should be perseveringly exercised to prevent any loss of motion of the joint.

Fracture of the Metacarpus.—The metacarpal bones suffer most

frequently from fracture caused by direct violence; indirect force may also cause it, as when a heavy blow is struck with the clenched fist.

The first and fifth metacarpal bones are more often broken than the others.

From the close connection between these bones no vertical displacement can take place; the ends of the fragments may be pushed in any other direction, though, perhaps, it most frequently occurs backwards.

Treatment.—The treatment is simple; consisting in the application of a wooden or gutta-percha splint to the back of the hand and forearm, with suitable compresses to correct displacements.

My experience during the late war in gunshot fractures of both the carpus and metacarpus, attended with profuse suppuration, led me to prefer an apparatus consisting of a wire frame, applied to the dorsal surface of the limb, reaching from a point just below the shoulder to the tips of the fingers, and secured to it by broad strips of adhesive plaster; the limb was then suspended in the frame by a cord hanging from the ceiling, or from the top of an upright lashed to the bedside. This arrangement permitted the easy application of water-dressings, or irrigation, and as it allowed the hand to be placed in most any posture, it facilitated the escape of pus.

Fracture of the Phalanges.—Fracture of the phalanges results from the same causes that produce this injury in the metacarpus.

The fragments may be displaced laterally, or be rotated upon their axis.

Treatment.—Redress any displacements of the fragments that may exist by making extension and pressure upon the phalanges, and then apply a gutta-percha or pasteboard splint, which must be secured with a narrow roller, or strips of adhesive plaster. If anchylosis threatens to occur, the fingers should be kept in a slightly bent position.

Fig. 365.

Splint for fracture of the bones of the fingers.

A splint sometimes used in treatment of fractured phalanges is seen in Fig. 465.

SECTION IV.

FRACTURE OF THE BONES OF THE LOWER EXTREMITIES.

Fracture of the Pelvic Bones. 1. *Sacrum.*—Fracture of the sacrum is caused by direct and great violence applied to the back of the pelvis. Its seat is commonly below the sacro-iliac symphysis, and its direction transverse. The lower fragment is displaced forwards towards the rectum, and in two of the recorded cases of this injury compressed that bowel.

Treatment.—An effort should be made to replace the lower fragment in its normal position by exercising pressure upon its anterior surface with the finger introduced into the rectum. As there is no tendency of the fragments to become displaced after the reduction, it is only necessary to put the patient into a recumbent posture, and to combat local inflammation.

2. *Coccyx.*—Fracture of the coccyx results from falls upon the nates, and from blows inflicted upon the lower extremity of the spine by kicking. The bone is most always displaced inwards.

Dr. Roeser records a case (*Froriep's Notizen,* 1857, Bd. II., No. 10) in which the coccyx was displaced laterally. It occurred in a large, corpulent woman, thirty-six years of age, who fell from a table upon which she was standing astride the back of a low wooden chair. Upon examination, a small swelling was felt on the left side of the fissure of the buttocks, which proved to be the coccyx torn away from the sacrum, and carried towards the descending ramus of the left ischium. The reduction was accomplished by making firm pressure downwards and to the right against the displaced bone.

Treatment.—The treatment of this injury is the same as in the previous case.

3. *Ilium.*—The ilium may be fractured at any point—acetabulum, ala, crest, or spinous process.

The acetabulum may simply have its edge knocked off, or be broken into several pieces, which may become so far separated as to permit the head of the femur to be shoved into the pelvic cavity.

This form of injury proceeds from the same causes as does fracture of the neck of the femur, though in general the force inflicted will be of greater intensity.

The diagnosis of fracture of the acetabulum, from a similar injury of the neck of the thigh-bone, and from iliac dislocation, is often quite difficult; though in the event of a mistake in this respect, little harm can result, inasmuch as the same line of treatment is required in both varieties of fracture.

If the edge of the acetabulum is broken away and the head of the femur persistently ascends in spite of the extension made upon the limb, the retention of the bone in the cotyloid cavity may be rendered more secure, by putting a broad belt around the pelvis, having fastened to its under surface a padded metallic plate of a semilunar shape to press against the trochanter, and thus offer a solid resistance to its ascent.

Should the acetabulum be split in several pieces and the head of the femur sunk into the pelvic cavity, the pelvic belt would be useless, and extension alone should be depended upon.

When the superior spinous process is separated from the ala, the patient should be placed upon his back and the lower extremities flexed and supported on cushions so as to relax the sartorius muscle.

4. *Pubis and Ischium* (Fig. 366).—Fractures of the pubis and ischium are often associated together, and are always caused by great violence applied to the pelvis, as when a person is crushed under a falling

Fig. 366.

Fracture of the pubis and ischium.

wall or between two cars. Fracture of the ischium has also resulted from falls, from a considerable height, upon the nates.

These accidents are always dangerous on account of the damage done to the viscera of the pelvic cavity—rupture of the bladder, urethra, or rectum.

Treatment.—The treatment consists in rectifying displacement of the fragments, if any should exist, by introducing the finger into the rectum; or, in the female, into the vagina, and pressing them into their natural position.

A catheter should be at once passed into the bladder and its condition ascertained.

The patient must be put to bed with his body in that position which is most comfortable to him; no apparatus is required except, perhaps, when the line of fracture has passed through the symphysis pubis and accompanied with a separation of the pubic bones, then, as recommended by Sir A. Cooper, a pelvic belt may be applied to bring them together.

Perineal abscess, resulting from effused urine, must be promptly evacuated by deep incisions.

FRACTURE OF THE FEMUR.—Fractures of the femur may be divided into: 1. Fractures of the upper extremity; 2. Of the shaft; and 3. Of lower extremity of the femur.

1. *Fracture of the Upper Extremity of the Femur.*—Under this head are placed: 1. Fracture of the neck of the femur; and 2. Fracture of the trochanter major.

a. *Intra-Capsular Fracture of the Neck of the Femur.*—In intra-capsular fracture of the neck of the femur the line of fracture, as the name implies, passes through the neck of the bone inside of the capsular ligament.

Its position is usually quite near the articulating head of the bone, as seen in Fig. 367, though it may occur at any point of the neck; in Fig. 368 the fracture is seen at its base.

The line of fracture is commonly observed to be oblique; in some cases it is transverse.

Instances have been recorded of incomplete fracture occurring in this portion of the bone; in most cases the fragments are completely separated, though rarely they have been found impacted or interlocked by the close contact of opposing surfaces presenting corresponding indentations and projections.

If the fragments are free, the muscles will pull the lower fragment upwards and backwards, and, in conjunction with the weight of the

limb below, rotate it outwards, while the head of the bone remains immovable in the acetabulum.

Fig. 367.

Fig. 368.

Intra-capsular fractures.

Causes.—Intra-capsular fracture is generally caused by some moderate force acting upon the knee or foot, forcing the femur toward the acetabulum, as sometimes occurs in making a misstep, or tripping and falling upon the knee.

Fig. 369.

External characteristics of fracture of the neck of the femur.

It is scarcely ever met with in persons under fifty years of age; beyond this period the bones undergo more or less change of structure—the cellular substance of the neck of the femur becomes more rarefied and its compact structure thinner. In old women, too, the angle formed by the neck with the shaft diminishes, and the former is thereby less able to resist the influence of external forces than it would be if nearer the axis of the shaft; these circumstances strongly predispose persons beyond the age mentioned to the occurrence of this injury.

Falls upon the hip will also produce fracture of the neck, and cases are related where muscular force alone caused it.

Symptoms.—The external characteristics of the fracture are seen in Fig. 369. The patient stands upon the uninjured extremity with the body inclined forwards; the fractured limb is shortened, the knee and foot strongly everted, while the heel is raised from the ground and rests in the hollow between the tendo-Achillis and the internal malleolus of the ankle of the opposite limb. The patient cannot walk, and the slightest pressure of the foot of the injured

leg upon the ground causes pain in the hip-joint; the trochanter major will be found nearer the crest of the ilium than its fellow, and at the same time is less prominent.

If the patient be placed in the recumbent posture, the broken limb will still be everted by its own weight and the contraction of external rotation muscles.

By the application of moderate force the broken limb may be restored to its normal length, and during rotative movements crepitus will be most always perceptible by placing the ear over the hip; the moment the extending force is withdrawn the limb shortens again. During these manipulations preternatural mobility at the seat of injury will be marked.

The shortening will vary from a few lines to an inch and a half, according to the damage done to the capsular ligament, and the position of the fragments as regards each other; for if these are impacted or held in approximation by their serrated surfaces, the diminution in the length of the limb must be inconsiderable; an unruptured capsular ligament would scarcely permit more than an inch shortening.

The decrease in the length of the limb may not be observed to follow the injury immediately, but three or four days may elapse when by some sudden movement of the patient, turning in bed, for instance, the limb will become at once shortened. The most plausible reason of this seems to be the slipping of the fragments from each other, that have hitherto, by some peculiarity of their surfaces, been held in contact. In other instances the limb gradually shortens within the first five or six months succeeding the injury.

The symptoms enumerated above will attend in almost all cases of fracture of the neck of the thigh-bone; in those attended with impaction crepitus will not be present, unless injudicious movements be impressed upon the limb. It has also been recorded that the foot in rare instances has been found inverted.

Prognosis.—Patients recover from this injury in most cases, but as the union between the fragments is rarely ever osseous, unless impaction or an interlocking has occurred, the functions of the limb will be more or less impaired; though under the worst circumstances the fibro-ligamentous connection that will be established between the pieces will be sufficiently firm to enable them to walk tolerably well. In other cases absorption of the fragments occurs to such an extent as to render the limb useless.

Treatment.—The treatment of intra-capsular fracture requires the exercise of judgment and discrimination in the selection of the means that ought to be employed in the different cases of this injury.

The indications of treatment are plain, namely, to bring the fragments into accurate contact, and to retain them in that position until the union, of whatever nature that may be, either osseous or ligamentous, occurs. But some of the patients are old, broken down in health, and very irritable, who could not bear the necessary confinement and restraint a sufficiently long time to obtain so desirable a result. In these cases the plan recommended by Sir A. Cooper may be followed, which consists in placing the patient in bed with the fractured limb

supported upon a pillow, and another pillow rolled up and interposed between the knees, keep him in this position a fortnight until the inflammation about the joint has subsided, then let him rise and sit in a high chair; in the course of time the patient will be enabled to get about upon crutches, which, as the convalescence proceeds, may be laid aside for a walking stick.

In other cases, where the health is good and the person not too old, efforts should be made by means of suitable apparatus to bring the fractured ends of the bone in contact so that when the ligamentous union does occur it may be as close as possible.

To carry out this object those splints should be selected which make extension upon the limb, prevent the eversion of the foot, and exert some pressure upon the trochanter major.

In the opinion of Dr. Hamilton, splints constructed upon the principle of Gibson's modification of Hagedorn's apparatus are best calculated to procure the desired result.

The manner of applying this apparatus "consists in extending the patient's limbs upon a mattress, and confining both feet, by gaiters, or a handkerchief, to a foot-board, which is firmly supported upon the ends of two splints passed through mortises near its edges. These splints extend from the armpit, where they are padded like the head of a crutch, along each of the body, thigh, and leg, beyond the foot, and, being well stuffed on their inner surfaces to prevent irritation, are confined by six or eight tapes or bandages passed around the limbs, pelvis, and chest." (Fig. 370.)

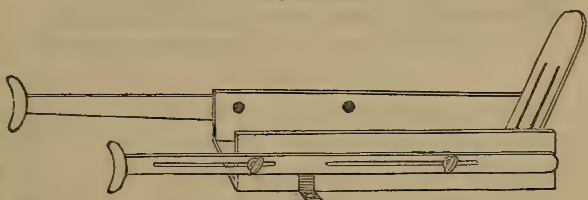
Fig. 370.

Gibson's modification of Hagedorn's apparatus.

"The principle upon which extension and counter-extension are effected by this contrivance, will instantly be understood. The sound limb being extended, serves as a splint to the broken one. Counter-extension then is made upon the *acetabulum of the sound side,* and extension upon the ankle of the injured limb, which, so long as the two feet are kept on the same level, cannot be shortened, provided rotation of the pelvis be prevented. This purpose is answered by extending the splints to the armpits; and not with a view, as might be supposed, of producing counter-extension from these points. Finding that the patient, in the original machine of Hagedorn, could incline the pelvis towards the affected side, and thereby shorten the limb, by causing the superior fragment to descend and overlap the inferior, the additional splint was added, and has been found to answer completely the end designed."

In my opinion, a much more serviceable and less cumbersome apparatus is the one recommended by Prof. Gross. This distinguished surgeon states that he employed it for the first time upwards of twenty years ago, and has had no reason to abandon its use since in the treatment of fractured thigh. The apparatus is so simple, and the materials of which it is composed so universally distributed, that the surgeon can prepare one in a few minutes wherever he may happen to be. It consists of a box made of some light wood, extending from the tuberosity of the ischium to the sole of the foot; its floor is grooved, that it may more accurately accommodate the posterior sur-

Fig. 371.



Gross's fracture apparatus.

face of the limb; the sides of the box are as deep as the antero-posterior diameter of the thigh, and they are connected by hinges to its floor. To the outer surface of the box a movable splint, about two inches wide, crutch-shaped at its upper extremity, which is intended to reach as far as the axilla, is connected. Another splint, similarly constructed, is attached to its inner side, and designed to press against the perineum; an ordinary footboard, with two slits in it, is placed at the lower end of the box.

In applying the apparatus the box should be well padded with cotton or tow, or, what is better, wheat bran—especially in compound fracture, where there is much discharge. Two long strips of adhesive plaster are placed upon the sides of the leg, and secured by a third running spirally; over this the turns of a roller are laid from the foot upwards. The limb, having been properly extended, is now put into the box, the inner crutch well pressed up against the perineum, and the outer one against the axilla; the extending strips are passed through the slits in the footboard and secured to it, after the requisite amount of extension has been made. To render the foot more steady, it may be further secured to the board by a roller bandage. Lastly, a broad splint of leather or binders' board is moulded to the anterior surface of the thigh, reaching from the groin to the knee, and secured in place by means of pieces of tape encircling the box.

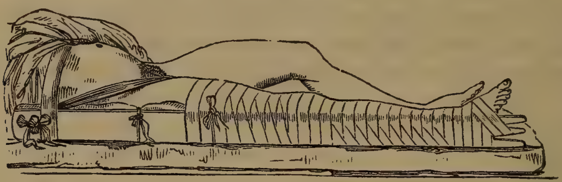
The principle upon which this apparatus is constructed is evident, the counter extension is established at the perineum and axilla, while extension is made from the leg by means of the adhesive strips.

The *long splint*, known as Liston's, may also be employed in this fracture, but extension cannot be made with it with as much force and regularity as with the previous splints, and hence it is rather adapted to those cases of impacted fracture, in which little or no force

of the kind is required, but the limb is simply to be held at rest while the union is being effected.

This splint is made of deal-board, or other light wood, of a hand's breadth for an adult, but narrower and slighter for a child; it should be long enough to reach from a point on a level with the nipple to a

Fig. 372.



Liston's splint.

point three or four inches beyond the foot. On its upper end there are two mortises, and at its lower end two deep notches, forming three teeth-like projections; at the point corresponding with the ankle a hole is to be made to accommodate the external malleolus.

The splint is to be well padded with cotton-batting, or layers of blanket, when it will be ready for use. The injured limb is to be prepared by bandaging it from the toes to the groin; and while an assistant makes extension from the foot, the straight splint is laid upon its outer side; the foot is secured to it by the turns of a roller passing around the ankle and across the notches in the lower end of the splint, and the bandage is then continued up the limb. The counter-extending band is now passed beneath the perineum, and its extremities fastened to the holes at the top of the splint.

An improved form of Liston's splint is recommended by Mr. Haynes Walton. As seen in Fig. 373, instead of the two notches at the

Fig. 373.

Walton's modification of Liston's splint.

lower end of the splint, he makes two long slits, by means of which the foot can be better secured, by making the purchase from the

Fig. 374.

Represents the two slits in Walton's splint.

ankle, and not upon the heel and dorsum of the foot. This arrangement also tends to keep the splint square with the leg.

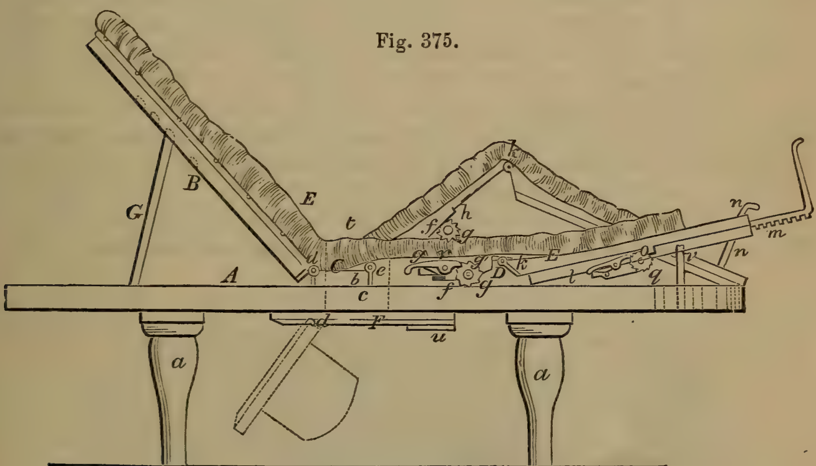
In the treatment of intra-capsular fracture the double-inclined plane has also been employed, and in some instances reported with flattering success.

An apparatus of this sort may readily be extemporized after the manner recommended by Dupuytren, which is as follows: Take cushions of different sizes and pile them upon one another until the double-inclined plane is of the requisite height; upon this repose the limb, and secure it to the plane by two long cravats extending in opposite directions across the thigh and ankle beneath the cushions.

The most perfect contrivance, perhaps, for intra-capsular fracture, is the *fracture-bed* of Dr. Daniels. It permits the limb to be placed in a straight or angular position, as the surgeon may require, and can be used in fractures of one or both extremities.

The bed is seen in Fig. 375. *A* represents a platform of a suitable

Fig. 375.



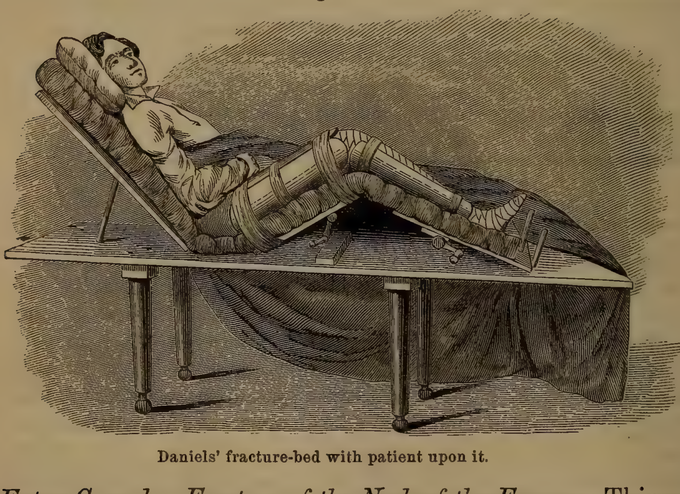
Daniels' fracture-bed.

length and width, and supported by four legs, *a*. To the upper surface of the platform *A* there is attached a cross-piece, *b*, at a short distance from the centre, and directly through the centre of the platform there is made a circular hole or aperture, *c* (in dotted lines), said hole or aperture having a semicircular cut or recess in the cross-piece *b*. To the straight edge of the cross-piece *b* there is attached, by hinges, *d*, a board, *B*, termed the body plane, the width of which may correspond with that of the platform *A*, and when depressed its outer edge may be even with the edge of the platform. The sides of the body plane may be elevated, or raised so as to be slightly concave on its outer surface. To the opposite side or edge of the cross-piece *b*, and at each side of the semicircular cut or recess formed by the hole or aperture *c*, there are attached by hinges, *e*, cast-iron plates, *C C*, which are provided with grooves or ways at their sides, in or between which plates, *D D*, work. The plates *C C*, *D D* (one on each side)

are thigh-plates, and their edges are provided with projections, *f*, in which a shaft, *g*, works, one on each plate *C*. On each shaft *g* there is placed a pinion, which gears into a rack attached to the under surface of the plates *D D*. At one end of the shafts *g* are attached ratchets, *g′*, in which pawls, *j*, catch, said pawls being attached to the sides of the plates *C C*. To the outer edges of the plates *D D* are attached by hinges, *k*, boards, *E E;* these boards are leg planes, and are slightly raised at their inner ends, where they are connected to the plates *D*, in order to form depressions to correspond to the shape of the legs. To the under surface of each leg plane there is attached a metal guide, *l*, in which a rack, *m*, works; the outer ends of the racks have bars, *n*, projecting from them at right angles. To each leg plane is attached a shaft, *o*, having a pinion, *p*, and ratchet, *q*, thereon, and pawls, *r*, which catch into the ratchets *q*, the pawls being attached to the outer sides of the leg planes. The pinions gear into the racks *m*. The body plane, and also the thigh and leg planes, are covered by a suitable mattress, *E*, with a hole made through it to correspond with the hole in the platform *A*, and the mattress is slit or cut to cover properly the thigh and leg planes without interfering with their movements. To the under side of the platform *A* there is attached by hinges a flap, *F*, having a stuffed pad or cushion, *t*, upon it, which, when the flap *F* is secured upwards against the platform, fits in the hole in the platform and mattress. The flap is secured against the platform by a button, *u*."

Fig. 376 represents the bed with a patient upon it, having the appropriate dressings and splints applied for a fractured thigh.

Fig. 376.



Daniels' fracture-bed with patient upon it.

b. *Extra-Capsular Fracture of the Neck of the Femur.*—This variety of fracture is seen in Fig. 377. The injury is outside of the capsule and in the direction of the intertrochanteric line. It is commonly accompanied with impaction of the upper fragment into the lower, and with splitting off of one or both trochanters.

Fig. 377.

Extra-capsular fracture.

Causes.—Falls or blows upon the hip are the most frequent causes, though the fracture may also result from counter-stroke—the force being applied either to the knee or foot.

Symptoms.— In the unimpacted varieties of this injury, the symptoms will be pretty much the same as those observed in intra-capsular fracture. If the fragments are held together by impaction, of course crepitus will not be perceived, nor can the leg be restored to its normal length by moderate extension.

The following table, taken from Dr. Hamilton's excellent *Treatise on Fractures and Dislocations,* will exhibit at a glance the chief points of difference:—

SIGNS OF A FRACTURE WITHIN THE CAPSULE.	SIGNS OF A FRACTURE WITHOUT THE CAPSULE.
1. Produced by slight violence.	1. Produced by greater violence.
2. A fall upon the foot or knee, or a trip upon the carpet, &c.	2. A fall upon the trochanter major.
3. Patients generally over fifty years of age.	3. Often under fifty years of age.
4. More frequent in females.	4. Relative frequency in males and females not established.
5. Pain, tenderness, and swelling less, and deeper.	5. Pain, swelling, and tenderness greater and more superficial. It is especially painful to press upon and around the trochanter.
(The two following measurements to be made from the anterior superior spinous process of the ilium to the inner condyle of the femur.)	
6. Shortening at first less than in extra-capsular fracture, often not any.	6. Shortening at first greater, almost always some.
7. Shortening after a few days or weeks greater than in extra-capsular fractures; sometimes this takes place suddenly, as when the limb is moved, or the patient steps upon it.	7. Shortening after a few days or weeks less than in intra-capsular fractures. That is, the amount of shortening changes but little, if at all; if the impaction continues, not at all; if it does not continue, it may shorten more.
8. Measuring from the top of the trochanter to the inner condyle, or to the malleolus internus, the femur is not shortened.	8. Measuring from the top of the trochanter to the inner condyle, or to the malleolus internus, the femur may be found a little shortened.
9. More mobility of limb, at joint.	9. Less mobility.
10. Trochanter major moves upon a longer radius.	10. Trochanter major moves upon a shorter radius.
11. If the patient recovers the use of the limb, not restored under three or four months.	11. If the patient recovers the use of the limb, restored in six or eight weeks.
12. No enlargement or apparent expansion of the trochanter major, after recovery, from deposit of bony callus.	12. Enlargement or irregular expansion of trochanter, which may be felt sometimes distinctly through the skin and muscles.

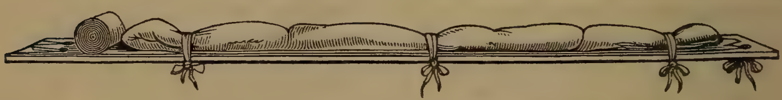
SIGNS OF A FRACTURE WITHIN THE CAPSULE.	SIGNS OF A FRACTURE WITHOUT THE CAPSULE.
13. Progressive wasting of the limb for many months after recovery.	13. The limb preserving its natural strength and size.
14. Excessive halting, accompanied with a peculiar motion of the pelvis, such as is exhibited in persons who walk with an artificial limb.	14. Slight halt, motions of the hip natural.

Prognosis.—Although osseous consolidation generally occurs after extra-capsular fracture, yet this injury should always be considered of a grave character, both on account of the damage done to the bone itself, and the constitutional disturbance it may involve.

If splitting of the trochanters complicate the fracture, it will be difficult under any treatment to obtain a favorable result, as far as the utility of the limb is concerned. Impacted fractures are less serious than those not so.

Treatment.—The treatment of extra-capsular fracture may be conducted with the apparatus already described, or with the contrivance of Prof. Miller, which consists of a straight light wooden splint (Fig. 378). "It should extend from a little below the axilla, to a little be-

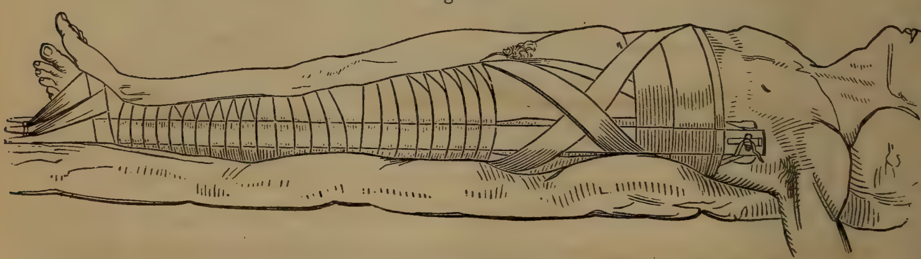
Fig. 378.



Miller's splint for fracture of neck of femur.

yond the ankle, when the patient is straight and recumbent; and, having been well padded, more especially at the points where pressure is likely to be greatest—at the trochanter, external condyle, and malleolus, or by the swathing of a broad linen sheet. Then a soft shawl, or other suitable band is pressed beneath the perineum, on the affected side; and has both its ends tied on the upper end of the splint, there being two holes placed there for this purpose."

Fig. 379.



Miller's splint applied.

"A broad bandage or belt is also applied firmly round the pelvis, so as to bind the splint more securely on the limb, and keep the broken surfaces in apposition. By tightening the perineal band, from time to

time, the splint is forced downwards; the splint, having been made of a piece with the limb, brings the latter with it."

c. *Fracture of the Neck of the Femur, partly Extra-Capsular and partly Intra-Capsular.*—This variety of fracture of the neck of the femur results from the same causes that produce extra-capsular fracture.

Union by bone takes place between the fragments.

This fracture will be characterized by the same set of symptoms that we have already described under the head of intra-capsular fracture; and will require in its treatment the apparatus we have just now considered.

d. *Fracture of the Trochanter Major.*—Fracture of the larger trochanter is commonly found as a complication of extra-capsular fracture, yet in rare cases it has been detached from the shaft of the femur without any other injury to the bone, the line of separation running downwards and outwards.

In young subjects an epiphyseal separation has also been recorded.

The trochanter is not generally displaced, in consequence of some of the soft tissues connecting it with the shaft remaining untorn.

Causes.—It may occur at any age, though in the cases reported it has taken place in old persons from a blow upon the hip.

Symptoms.—The limb is perfectly helpless, and lies in an everted position; by measurement it will be found of the same length as the opposite one. When the thigh is rotated the trochanter does not participate in the motions of the femur. If displacement occurs, it will be either upwards or backwards, generally the former; if the limb be abducted and the trochanter brought down, the broken surfaces may be pressed in contact, and crepitus developed by rubbing them together; should the patient be in the erect posture, he cannot sit down, from the extreme pain which efforts to do so cause him.

Treatment.—Sir A. Cooper recommends the apparatus sketched in the annexed wood-cut, in the treatment of this injury. He places the

Fig. 380.

Sir A. Cooper's apparatus for the fracture of the trochanter major.

patient upon a firm mattress, provided with an arrangement for using the bed-pan; at its lower end an upright support is attached, to which the foot is secured. A broad belt is made to encircle the pelvis, so as to sustain the trochanter in its normal position. To hold the leg immovable, after the application of the pelvic belt two lateral splints may be applied.

The apparatus should be continued for a month, when the patient may be permitted to get up and move around.

In most cases union by bone has taken place promptly without any danger being inflicted upon the functions of the hip-joint.

2. *Fracture of the Shaft of the Femur.*—Fracture of the shaft of the femur may occur at any point in its length, but is most frequent in its middle third. The character of the fracture is various, it may be simple or comminuted, compound or complicated with other injuries. Its direction is commonly oblique, though when it takes place at the base of the condyle, or in young subjects it is often transverse.

Fig. 381.

Fracture of the base of the condyle.

The displacements that follow depend upon the position of the fracture; if this is towards the upper end, the psoas magnus and iliacus internus will tilt the upper fragment forwards, while the large adductors upon the inner side of the thigh will draw the lower fragment upwards and inwards, behind the upper, and at the same time will rotate it outwards.

In fracture seated about the middle of the femur the lower fragment will be displaced as in the former case, but the upper one will rather be drawn a little outwards, and ride over the lower.

Transverse fracture just above the condyles, from the breadth of the opposing surfaces may not be attended with any displacement, but if it is oblique, the lower fragment will be drawn backwards and downwards by the gastrocnemius, plantaris, and popliteus.

Symptoms.—There is usually shortening to a considerable extent; preternatural mobility at the point of fracture when the limb is lifted from the bed; the patient cannot move the leg; the foot is everted; and crepitus will be developed by rubbing the fragments against each other.

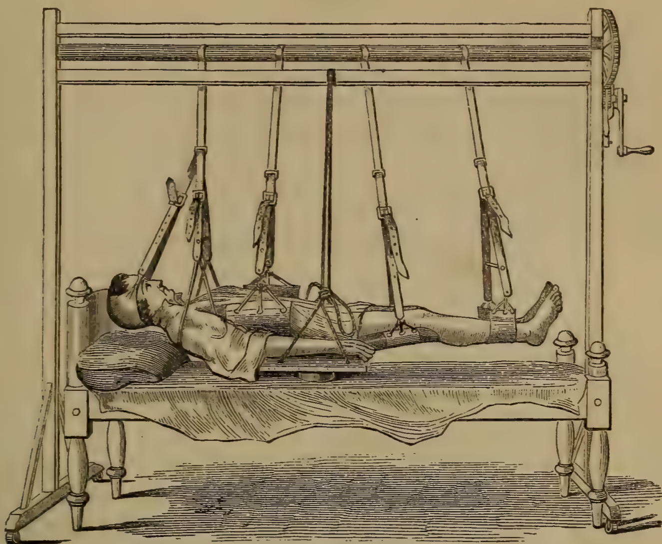
Prognosis.—Fracture of the shaft of the femur is always a serious injury, and when the line of division is oblique, it is almost impossible by any apparatus to procure a cure without some shortening.

Treatment.—In the treatment of this injury it is of great importance to procure a suitable mattress upon which to place the patient during the period of his confinement. If it is possible to obtain one, a fracture-bed should be chosen in which provision is made for all the requirements of the case.

We have already described the fracture-bed of Dr. Daniels. It offers many advantages in conducting the treatment of fracture of the femur; there are others also equally as efficient, and require a passing notice. The fracture-bed invented by Mr. Jenks, of Providence, Rhode Island, will be found ingenious and useful. "It is composed of two upright posts about six feet high, supported each by a pedestal—of

two horizontal bars, at the top, somewhat longer than a common bedstead—of a windlass of the same length placed six inches below the

Fig. 382.



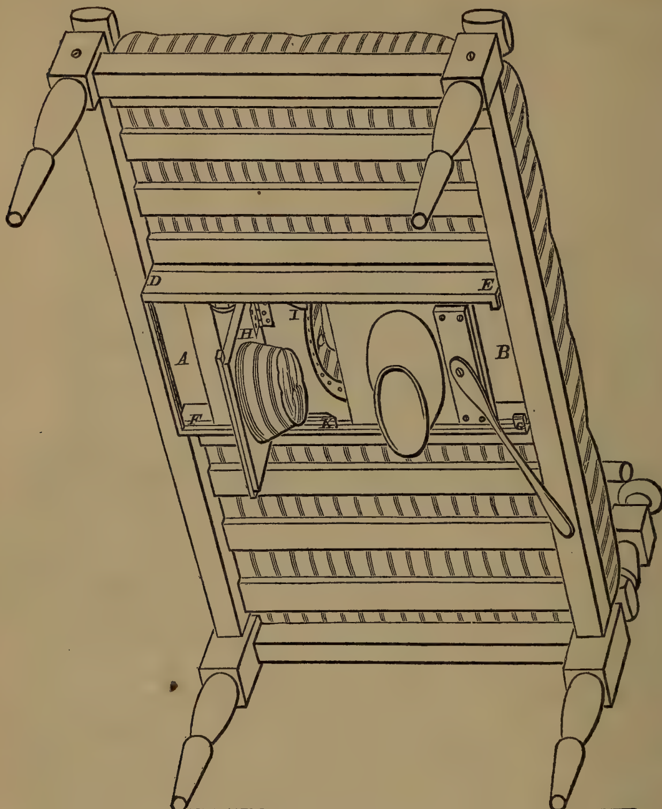
Jenks' fracture-bed.

upper bar—of a cogwheel and handle—of linen belts, from six to twelve inches wide—of straps secured at one end of the windlass, and at the other having hooks attached to corresponding eyes in linen belts, from six to twelve inches wide—of straps secured at one end of the windlass, and at the other having hooks attached to corresponding eyes in the linen belts—of a head-piece made of netting—of a piece of sheet-iron twelve inches long, and to fit and surround the thigh—of a bed-pan, box, and cushion to support it, and of some other minor parts. The patient, lying on his mattress, and his limb surrounded by the apparatus, the surgeon, or any common attendant, will only find it requisite to pass the linen belts beneath his body (attaching them to the hooks at the ends of the straps, and adjusting the whole at the proper distance and length, so as to balance the body exactly), and raise it from the mattress by turning the handle of the windlass. While the patient is thus suspended, the bed can be made up, and the feces and urine evacuated. To lower the patient again and replace him on the mattress, the windlass must be reversed. The linen belts may then be removed, and the body brought in contact with the sheet."

A much less expensive contrivance than Jenks' fracture-bed is an arrangement devised by Dr. A. Hewson, and described by him in the *Am. Journ. Med. Sci.*, for July, 1858. It has also the great advantage of being easily connected with an ordinary bedstead. As seen in the figure, a board (*A B*, Fig. 383) fifteen or eighteen inches broad, and of sufficient length, is to be substituted for three or four of the slats

forming the bottom of the bedstead. The ends of this board (*A* and *B*) should be cut so as to fit in the mortises originally made in the sides of the bedstead for the slats. In the centre of this board there should

Fig. 383.



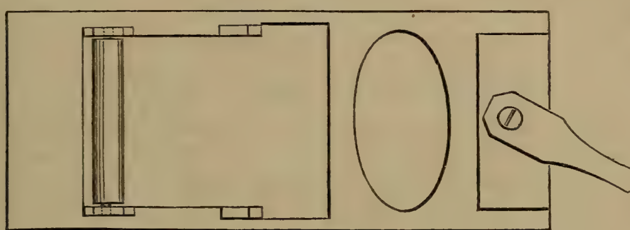
Hewson's fracture-bed.

be an oval hole (*C*) ten by seven inches, its long diameter corresponding to the length of the bedstead. To the upper and lower borders of this board there should be secured strips, *D E* and *F G*, extending between the sides of the bedstead. These strips should have grooves near their lower borders, and running their full length, as seen on *F G*, for the tray containing the bedpan to slide in. They (the strips) should have a depth sufficient to make the plane of these grooves below the plane of the sides of the bedstead. To the bottom of the board (substituted for the slats) there is to be hinged a trap-door, *H*, to which an oval and somewhat conical pad is to be secured. This door should have a length equal to a little over one-fourth the width of the bedstead, and a breadth of twelve inches. It may be made of one inch stuff, and should then have secured, at equal distances on its under surface, two or three strips an inch broad, and with a depth sufficient

to bring their lower surface (when the door is shut up) on a level with the upper edge of the grooves in the side-pieces, on the upper surface of the tray. These strips should terminate in a cross-piece at the far end of the door, and this last piece should extend an inch on either side beyond the door.

A tray (Fig. 384) of sufficient width to slide in the grooves of *D E* and *F G*, Fig. 383, should be made of one inch stuff, and have a length equal to five-eighths the width of the bedstead. This tray should have in it an oval hole ten by seven inches for the pan, and a square hole

Fig. 384.



fully equal in length and breadth to the door, save at the end near the hole for the pan; here this square opening should be increased in width by the removal from either corner of a piece one inch by two and a half inches, so as to allow the jutting ends of the cross-piece attached to the door to fall through as the pan is pushed towards the hole in the bed, or to rise up above the tray when it is desired to remove the pan and replace the plug. To close up the door, and thus replace the plug in the mattress, without any friction or jarring, a wooden roller of two and a half inches diameter should be secured to the under surface of the tray at the far end of the square opening, and at such a distance from the notches for the escape of the cross-piece of the trap-door as will be equal to two-thirds the length of the door. The tray is to be moved by a handle attached to it by a pivot.

For the purpose of preventing the attendant from pushing or pulling the tray too far in either direction, stops should be provided, such as are indicated at *D E* and *F G*. Thus at *D E* there is a strip extending between the cleats which will check the tray in that direction by the roller striking against it. Then the tray cannot be drawn out too far by the two little points on the bottom of the tray, at *I* and *K*, infringing on the stops indicated at *E* and *C*.

These last checks allow of the tray being drawn out sufficiently far from beneath the bed for the removal of the pan, and when the tray is drawn out this far, the trap-door is supported up in its place by the jutting ends of the cross-piece resting on the distant end of the tray. These jutting ends continue to support the door as the tray is pushed in, until it is pushed so far as to bring the notches in the square opening beneath these ends, when all support is removed from the door, and it falls rapidly by its own weight; then, by continuing to

push the tray inwards, the pan is brought beneath the opening in the bed.

A hole should be made in the mattress to correspond with that in the board. It should be oval, and measure ten by six inches on the upper surface. The far side of this hole (from the hinges of the door) should be bevelled, so that it will measure in the lower surface ten by seven inches. To prevent the weight of the patient pressing the mattress over into this opening, the edge of the hole in the board should be bound round with tin, jutting an inch and a half above its upper surface.

The apparatus will work best when the hinges of the door are as far as possible from the hole, and the plug placed as near as it can be to the free end of the door. The plug will thus be made to describe the arc of the largest circle possible in the swinging of the door, and will therefore not require to be bevelled as much as it would if placed in the centre of the door, and the door hinged nearer to the opening. The bevelling of the plug and of the hole in the mattress is only required on one side—the side towards the handle of the tray—and if this bevelling is made to correspond with the arc of the circle described by the upper and far edge of the plug, the plug will fit with great accuracy in the opening. This plug should be secured firmly to the door, either by being tacked to it or fastened by tapes passed through holes provided for the purpose.

When these more convenient and perfect apparatus are not attainable, the surgeon can extemporize a simple arrangement, by means of which the patient's position need not be disturbed in using the bedpan or changing the bedclothes. It is thus prepared: Upon the mattress intended to be lain on by the patient, a piece of stout canvas is spread, and kept stretched by being nailed or sewed to an ordinary cot frame. In its centre, corresponding to the nates, a hole is cut. Two sheets are doubled and placed over the canvas, with their folded margins meeting at the hole. The sheets and frame should lie smoothly upon the mattress, that no inequalities be presented beneath the patient to hurt his skin. When it is necessary to use the bedpan, all that is necessary is to raise the patient from the mattress with the cot frame, and support it by four blocks placed under its corners; or, what I always use, a rope attached to the two ends of the frame, and running over the cross-pieces of the bedposts. The pan may then be shoved beneath him, the folded edges of the sheets having been previously turned aside.

When the surgeon has selected and prepared his bed, he is then to apply his splints, of which there are a great variety employed in the treatment of fracture of the shaft of the femur. Some surgeons employ, in all cases, splints that maintain the limb in an angular position; others, those that keep it straight; while a third class use both kinds—the angular, in fractures of the upper and lower ends of the femur, and straight splints in fracture of its middle portion.

Mr. Pott was the first to bring into notice, and cause to be adopted, the treatment of fracture of the thigh with the limb in a bent posture. His object was to relax those muscles which he believed to be the

principal agents in deranging the fragments by their contraction. The fact did not seem to occur to Mr. Pott that, in thus relaxing one set of muscles, he must necessarily put those opposing them in a proportional degree of extension. However, the principal objections to Pott's plan are, that the limb is not properly secured, and therefore is constantly liable to be disturbed, and the fragments displaced; and that the weight of the body is sustained upon the trochanter of the injured side for too prolonged a period to escape injury. I have employed the method with advantage in certain cases of gunshot fracture, with laceration of the soft tissues.

Mr. Pott directs that "the position of the fractured os femoris should be on its outside, resting on the great trochanter; the patient's whole body should be inclined to the same side; the knee should be in a middle state, between perfect flexion and extension, or half bent; the foot and leg lying on their outside also, should be well supported by smooth pillows, and should be rather higher in their level than the thigh; one very broad splint of deal, hollowed out, and well covered with wool, rag, or tow, should be placed under the thigh, from above the trochanter, quite below the knee; and another, somewhat shorter, should extend from the groin below the knee on the inside, or rather in this posture on the upper side; the bandage should be of the eighteen-tail kind; and when the bone has been set, and the thigh well placed on the pillow, it should not, without necessity (which necessity in this method will seldom occur), be ever moved from it again until the fracture is united; and this union will always be accomplished in more or less time in proportion as the limb shall have been more or less disturbed."

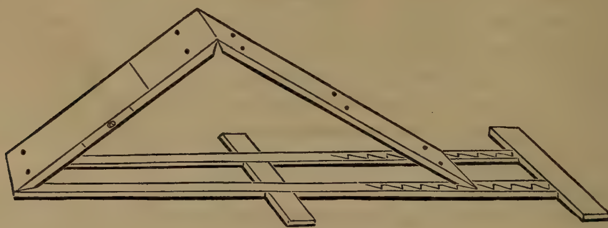
To obviate the objections to Pott's plan Sir C. Bell recommended a modification of the bent posture, the peculiarity of his method consisting in supporting the limb upon a double-inclined plane, the patient lying upon his back. The plane was constructed of two boards ten or eleven inches wide, joined together at such an angle under the popliteal space that the hip and knee-joints should be slightly bent. A cushion was laid over the frame, and in order to give support and steadiness to the limb and prevent the lateral inclination of the foot, a number of holes were bored in the margins of the boards to receive wooden pins, which held the sides of the cushion against the leg. When the fracture was reduced and the limb placed upon this apparatus, two splints were secured to the sides of the thigh by an eighteen-tail bandage.

Many modifications of this apparatus of Bell have been employed since. The one seen in Fig. 385 was used at the Middlesex Hospital, London, according to Mr. Lonsdale, in 1838.

It differs from the preceding one in having a horizontal board attached by one extremity to the upper end of the thigh-plate, while the other extremity of the board supported the lower end of the leg-plate upon a number of notches, which enabled the surgeon to vary the angle according to his pleasure. The thigh-piece, which is hinged to the leg-plate, consists of two pieces instead of one, so that it may be adapted to limbs of different lengths.

In applying the apparatus it is recommended to pad it with flannel so as to make a smooth and uniform bed upon which to lay the limb,

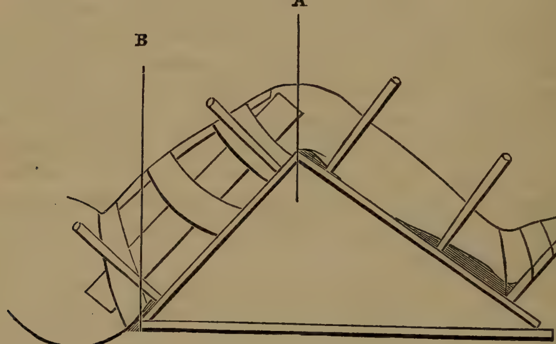
Fig. 385.



Double-inclined plane.

and then to secure to the front and sides of the thigh three splints with an eighteen-tail bandage. The foot is fastened to an upright support by the turn of a roller, which is to be continued upwards; to finish, the pegs are inserted into the holes along the sides of the boards. Fig.

Fig. 386.



The same applied.

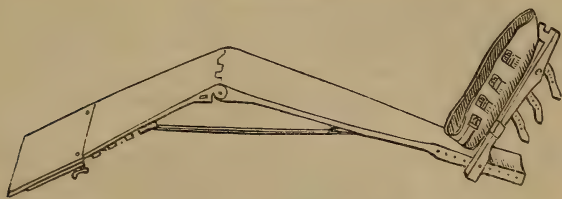
386 shows the apparatus applied; the lines A and B indicate the proper positions that the angle of the frame and the upper end of the horizontal board should occupy.

In using the double-inclined plane, the weight of the body is made to serve the purpose of a counter-extending force, and thus drawing upon the foot attached to the upright support establishes the extension, which certainly cannot thus be accomplished with any uniformity or to any great extent. From the fact of the pelvis not being in any manner connected with or controlled by the apparatus, it is at liberty to move in any direction, and will displace the upper fragment. In employing the apparatus, it will be found necessary to attempt to obviate this obstacle, and also to prevent the loss of contiguity of the two fragments by lateral deflection of the upper one, by shifting the position of the double-inclined plane, bringing it towards or removing it from the sound limb, according to circumstances.

Mr. Amesbury endeavored to fix the pelvis by the apparatus seen

in Fig. 387. It consists of three portions, one (*a*) for the thigh, another (*b*) for the leg, and a third (*c*) for the foot. To each apparatus

Fig. 387.

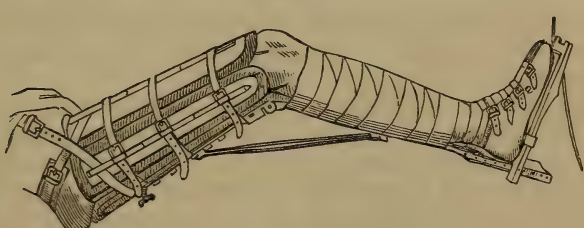


Amesbury's double-inclined plane.

there are two thigh-pieces, one bevelled to the right at the lower end, and the other to the left, one or the other being used in connection with the leg-piece, according as the apparatus is to be applied to the right or left extremity—for the reason that a perfectly formed limb is not straight, but turns inwards at the knee. The thigh and leg portions are connected together by a joint, which is controlled by a steel rod (*e*) attached by one end to the back of the leg-piece, and at the other moves in a rack placed upon the posterior surface of the thigh-piece, to which it can be secured at different points with a little pin; this arrangement allows the angle of the plane to be varied at pleasure. To the upper part of the thigh-piece there is a sliding plate which permits this piece to be adapted to limbs of different lengths; the plate itself is turned off at its upper edge so that, when properly padded, it may press against the tuberosity of the ischium without damaging the skin; it also has soldered to its back two bars, under which the pelvic strap passes. The pelvic strap is made of leather with a sliding pad upon it.

In the application of the apparatus it should be first well padded (Fig. 388); a roller bandage is then placed upon the leg from the

Fig. 388.



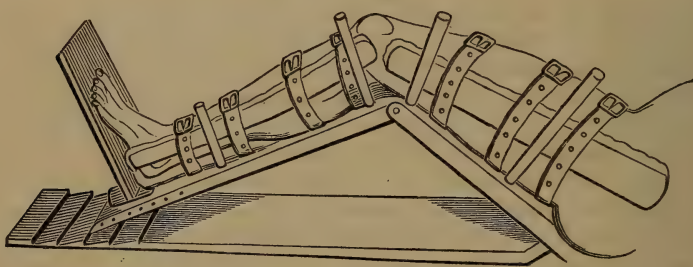
The same applied.

toes to the knee, and the limb placed upon the plane; the foot is inclosed in the shoe (*a*), supported by the footboard, nearly at right angles with the leg-piece; inequalities beneath the limb are corrected by stuffing between it and the splint cotton or tow. The leg is secured to the apparatus by the turns of a roller bandage reaching from the ankle to the knee. An assistant now makes extension by

seizing the knee while the surgeon coaptates the fragments and then applies the splint, the first to the outer side of the limb, the second upon its inner side, and the third upon the front part of the thigh; the splints are held in place by the straps. The pelvic strap is now carried around the thigh, and made to cross on the outer side, while the *buckle-end*, with the sliding pad, is carried around the pelvis and made to meet the other end in front, where they are fastened together. The lower part of the apparatus is fixed to the foot of the bed by the tapes.

Dr. J. C. Nott has also devised a double-inclined plane, which differs very little from the one described by Mr. Lonsdale. The tuberosity

Fig. 389.



Nott's double-inclined plane.

of the ischium rests upon the upper end of the thigh-piece; the thigh has two splints upon its sides, secured by buckles and straps, and so has the leg; the horizontal board consists of a single piece notched at its far end.

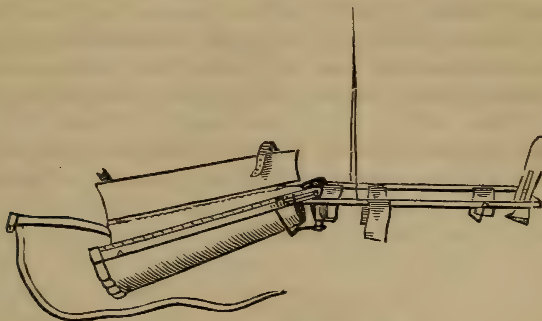
The inclined plane is also used by surgeons in the treatment of fractured thigh, suspended from the ceiling, or the top of the bedstead. It maintains the leg in the flexed position, and at the same time allows it to move laterally, or to participate with the trunk in any of its movements. The suspension plan is of real service, and I know of nothing superior to it in certain cases of compound fracture of the thigh, with laceration of the soft parts; and during the late war the anterior splint of Prof. N. R. Smith, of Baltimore, was deservedly held in high esteem by military surgeons in such cases.

Mayor's apparatus for fractured thigh consists of a wire frame, with a thigh and leg-piece fastened together at an angle which may be varied by the tension of a chain passing from the cross-bar at the upper end of the frame to the top of the bent section of the leg-piece, which is made to answer the purpose of a foot-board.

Upon this frame a cushion is placed, on which the limb is laid and secured by three cravats passing around the thigh, leg, and foot. A fourth cravat encircles the hips and upper part of the thigh, having its ends attached to the thigh-piece upon both sides; this secures the apparatus to the pelvis. The frame is now slung, by means of cords connected with the upper and lower corners of the leg section, from the ceiling or top of the bedstead.

The double-inclined plane of Prof. Smith (Fig. 390) is slung with cords in the same manner, but the apparatus is constructed with two

Fig. 390.



N. R. Smith's double-inclined plane.

lateral iron bars, jointed at their middle, and extending from the hip to the foot. The upper sections of these bars, corresponding with the thigh, are joined together by a metallic trough; the leg is supported by broad bands of webbing, passing between the bars of the lower sections, to the far end of which a footboard is attached. At the top of the outer bar a curved metal stem is placed bearing the pelvic strap.

In applying this apparatus, it is first to be padded with flannel or cotton-batting. The limb is now raised and extended by an assistant, while the surgeon places the frame beneath it and secures the foot to its board by a roller bandage; the leg-bands are fastened, and a broad splint, laid upon the anterior surface of the thigh, is secured by straps. The pelvic strap is passed round the hips, and buckled; and lastly, the apparatus is suspended by a cord from the ceiling.

The "anterior splint" of the same distinguished surgeon is formed of wood or wire, the latter being preferable. It is intended to be applied to the anterior plane of the limb, and slung from the ceiling.

Fig. 391.

N. R. Smith's anterior splint.

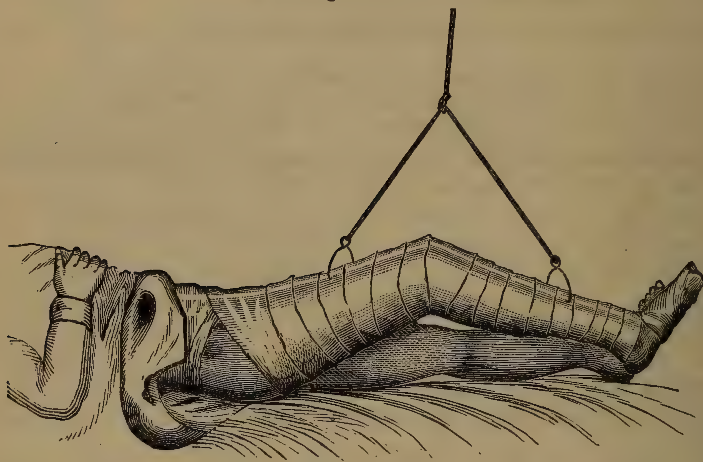
The wire splint (Fig. 391) may be prepared by the surgeon in a few minutes, whenever wire is attainable, of which Nos. 8 or 9 will answer the purpose; of this a piece is taken of sufficient length, when doubled and bent to the limb, to reach from the anterior-superior spinous process to a point two inches beyond the toes. The two sides of this are now expanded so as to be as broad as the limb; that is, wide above, and gradually tapering to the toes. To retain this form, cross-pieces of a smaller sized wire are connected with them; two of these cross

wires, one over the thigh and the other over the leg, have an eye worked in at their centres for the attachment of the suspending cord.

The wire frame thus prepared is bent at the groin, knee, and ankle, so as to lie in exact contact with the anterior plane of the limb, which is to be slightly flexed.

The splint is now enveloped in a layer of cotton batting, and encircled with a roller bandage and laid upon the limb. Three or four strips of adhesive plaster are applied round both splint and limb, at the sole of the foot, middle of leg, and thigh. These will support the parts, while the surgeon applies a roller bandage from the toes upwards. Arriving at the pelvis, a spica of the hip should be formed with the roller. When this is finished, the apparatus is to be slung from the ceiling by a cord, to which a certain degree of obliquity is to be given. (Fig. 392.)

Fig. 392.



The same applied.

The obliquity of the cord, and the application of the splint upon the anterior surface of the limb, are the peculiarities of Dr. Smith's apparatus. It is by the first that extension is made, which will, of course, vary in intensity with the degree of this obliquity. The cord, in this position, is constantly pulling the patient towards the foot of the bed, while the only resistance offered is by the weight of the body, which forms, therefore, the counter-extending force.

In compound fractures, resulting from gunshot, attended with laceration of the soft parts, I have employed this splint a number of times with the most decided advantage, and I think, under such circumstances, it has given more relief to the patient than any other contrivance I am acquainted with could have done. It facilitates the dressing and cleansing of the parts, does away with the constant disturbance of the limb for these purposes, and supports it in such a manner that it may be moved about with facility in a horizontal plane, permitting also the position of the patient to be changed without disturbing the limb.

Dr. James Palmer, U. S. N., has modified the "anterior splint" for double fracture, as seen in Fig. 393, and described in the *Amer. Journ. Med. Sciences,* No. 99, for 1865. It consists of two continuous parallel rods of No. 9 iron wire, passing over the anterior surfaces of both limbs from the toes upwards, arching over the pubes clear of the anterior spinous processes, and bent at the groins at an angle of about thirty degrees. The abdominal arch was well padded, and the whole apparatus, enveloped with roller bandages, as usual, was first secured to the pelvis, a trough of binder's boards being accurately moulded to the back of each thigh; bandages from the toes upwards were next applied around each limb, including the splint, and when they reached the groins were secured to the arch on each side, and the ends, finally carried over the mattress, clear of the patient's body, were made fast to the head of the iron bedstead, the weight of the body making the counter-extension. Lastly, the limbs, separately slung, were suspended by a single cord passing over a pulley at the ceiling, and making extension at an angle of about thirty degrees, as seen in Fig. 393.

Fig. 393.

Palmer's modification of the anterior splint.

Dr. Palmer suggests an improvement upon this by bending the wires outwards and downwards at the instep, and carrying them out parallel

with the soles of the feet, so as to secure to their ends a copper trough, to which the patient's own shoes may be attached for support at the heels.

Although there are certain cases in which it would be advisable to treat fracture of the thigh in the bent position, yet as a general method the straight position should be preferred. We have already indicated above the instances in which this preference should be exercised, viz., fractures just below the trochanter minor, in which the upper fragment is tilted upwards and somewhat outwards, and at the base of the condyles, the inferior fragment being acted upon by the muscles of the calf of the leg, and drawn backwards. In the first instance, by bending the thigh upon the pelvis, the psoas magnus and iliacus are relaxed, and the fragment into which they are inserted permitted to descend in line with the axis of the rest of the bone; and in the second, the flexion of the knee relaxes the muscles of the calf, which displace the lower fragment backwards.

This method of treatment was particularly recommended by Desault, and is generally adopted by American surgeons. The parts of this surgeon's apparatus are: 1st. Three splints, each one and a half inch wide, a long one to extend from the crest of the ilium to a point four inches beyond the foot, intended for the external surface of the limb; its ends are concave, and mortised; a second splint, somewhat shorter, for the inner surface of the limb, extending from the perineum to the sole of the foot; a third short splint, reaching from the fold of the groin to the knee. 2d. Three cushions filled with bran or oat chaff. 3d. A bandage of Scultetus, the strips of which are long enough to reach twice around the limb, overlapping each other about one-third of their breadth, and variable as to number, ascending to the requirements of the case. 4th. Two oblong compresses. 5th. Two strong strips of bandage for extension and counter-extension. 6th. A splint-cloth and body bandage.

The apparatus is applied by spreading upon the bed the splint-cloth, which may be a piece of stout muslin, two yards long and as wide as the inner splint; upon this the bandage of Scultetus is placed, reaching from the ankle to the hip. The limb having been laid on the centre of the bandage, extension is made from the leg, and the surgeon, having coaptated the fragment, puts one of the oblong compresses along the anterior surface of the thigh, and then applies the bandage of Scultetus; the ankle is padded with tow, or inclosed in a compress, and the extending band is applied; the three cushions are next put in position, and the lateral splints rolled up in the splint-cloth from its edges against the limb, so as to compress it uniformly; the third splint is placed on the thigh. Five strong bands are now fastened around the limb to secure the apparatus. The extending and counter-extending bands are passed through the mortises, and tied over the ends of the long splint; the upper extremity of this splint is bound to the side of the pelvis by a broad bandage. Any tendency to lateral deviation of the foot is prevented by passing a strip of bandage about it, and pinning it by its ends to the splint-cloth.

The objection to the apparatus of Desault is, that the extending and

counter-extending forces do not act in the line of the axis of the broken limb, but obliquely, so that the perineal band is constantly disposed to draw the upper fragment outwards.

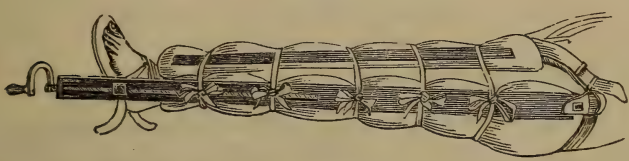
To obviate this Dr. Physick modified Desault's long splint by extending it up to the axilla, so as to bring the line of traction of the perineal band in the direction of the axis of the broken leg; he also observed that the extending band drawing with much force pulled the foot against the lower end of the splint and bent the ankle, and suggested to Dr. Hutchinson to have recourse to some expedient to correct the oblique traction; the latter gentleman then adopted the notched block nailed to the lower end of the splint, as seen in Fig. 394. This splint is otherwise like that of Desault's, and is applied in the same manner.

Fig. 394.

Physick's splint.

The next apparatus that has enjoyed the confidence of many of the continental surgeons is that of Boyer. It consists of an external long splint (Fig. 395), reaching from

Fig. 395.



Boyer's apparatus.

the hip to beyond the sole of the foot; its upper end is attached to the outer side of the counter-extending band, while the lower one is peculiarly constructed, by having a fenestrum cut into it, through which a long screw moves by a crank. The screw supports a plate to which the footboard is attached, and confers upon the latter a certain range of vertical motion. There are two other splints for the inner and anterior surfaces of limb. The lower end of the apparatus is supported upon the mattress by two projecting stems attached to the footboard.

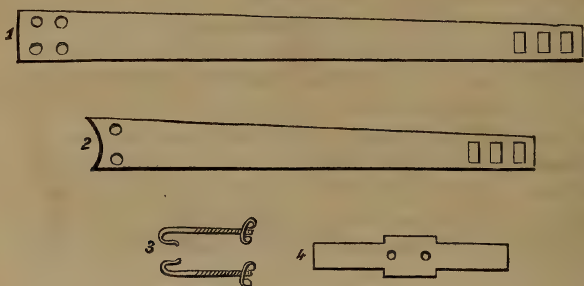
The splints are cushioned and applied in the same manner as the apparatus of Desault, already mentioned.

The peculiarity of Boyer's splint consists in the manner of making extension by fastening the foot to an upright support moved by a screw.

An apparatus constructed by Dr. Alonzo Chapin is seen in Fig. 396. The long splint (1) has four holes at its upper extremity, and three tenons at its lower, the latter corresponding with an equal number of tenons in the distal end of the inside splint are intended to support a transverse bar. Through the bar two holes are pierced for two hooked screws to work in; the screws are moved by nuts abutting against the outer side of the bar, and when the splint is applied the extending bands are hooked to the screws. The inside splint is concave at its proximal end and perforated with two holes through which the

counter-extending band passes and presses the splint against the perineum. The apparatus is applied in the usual manner to the limb

Fig. 396.

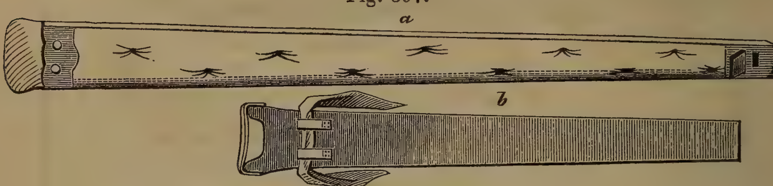


Chapin's apparatus.

protected with cushions. Should occasion require, the splints may be drawn asunder and the limb examined without disturbing it.

This peculiarity of the counter-extending band, acting upon the perineum by pressing the upper end of the inside splint against it, is also seen in the apparatus (Fig. 397) of Prof. W. E. Horner, which

Fig. 397.

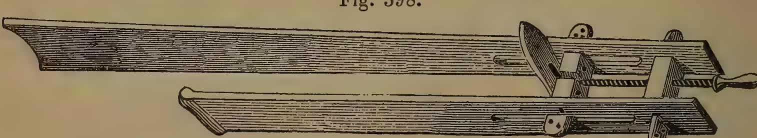


Horner's apparatus.

has, besides, the cushions immovably fixed to their inner surfaces. The end of the splint is notched, and spanned with a leathern strap, while the perineal band is attached below by passing under two leathern loops.

Dr. Joseph E. Hartshorne does away with the perineal band for counter-extension altogether, and in his apparatus, shown in the annexed drawing (Fig. 398), pads the upper end of the inside splint

Fig. 398.

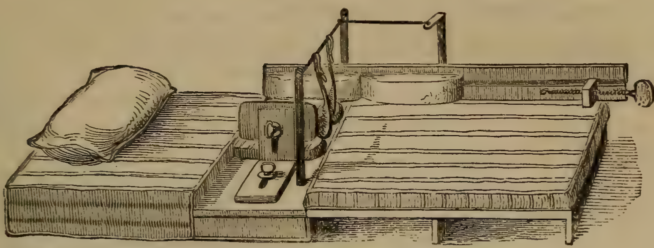


Hartshorne's apparatus.

to press against the perineum and make counter-extension. The two splints are connected below by two cross-pieces supporting a wooden screw, which moves the footboard. The splints may be separated from each other, and the long splint removed if the necessities of the case should demand.

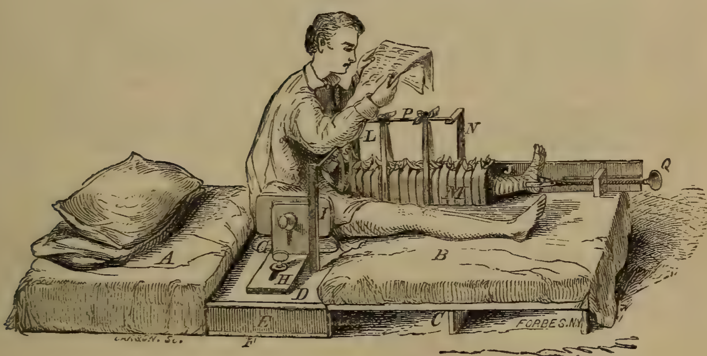
Drs. Burges have constructed an ingenious fracture apparatus, sketched in the following drawings (Figs. 399, 400), in which, to ob-

Fig. 399.



Burges' apparatus.

Fig. 400.



The same applied.

viate the injurious effects of pressure of the counter-extending band upon the perineum, they have transferred the resistance, in a measure, to the tuberosity of the ischium.

The apparatus consists of: "*A*, thick mattress. *B*, thin mattress. *C*, wooden platform upon which the thin mattress is laid. This platform is made in two pieces, and hinged together so as to fold upon itself for convenience of transportation, and when in use is merely hooked upon the central platform *D*.

"*D*, central or cushioned platform supported at either end by wooden strips marked *E*, which rest upon *F*, a second platform of same extent as *D*. This constitutes a shelf for the bed-pan, which may be introduced below from either side.

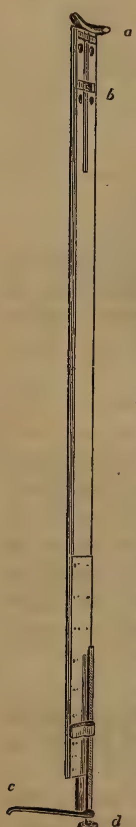
"*G*, hair cushion, upon which the hips of the patient rest. This cushion, as well as the platform *D*, to which it is buttoned, has a semicircular opening at its lower margin for convenience of defecation.

"*H*, a rectangular wooden slide, exactly corresponding to its fellow upon the opposite side of the pelvis. These slides are so arranged upon the platform *D* as to be separated or approximated at will, and, by a thumb-screw which passes through a fissure in the horizontal portion of each, they may be fixed at the desired point so as exactly

to embrace the pelvis of any patient. There is also a fissure in the perpendicular position of each rectangular slide, and a screw passing through the same. One of these is to secure the upper end of the long splint *J*, and the other for the attachment of a short splint *I*, upon the side of the pelvis, corresponding to the uninjured limb. Both of these splints are well padded upon one surface, and may be elevated or depressed at will, in order to bring them to the level of the limb and fixed at the proper altitude by the screws already mentioned. They are also mutually transferable, thus adapting the apparatus to fractures of either thigh.

"*SS*, counter-extending pads. These are attached by leather straps to the upper surface of the platform *D*, about twelve inches apart. Passing under the cushion *G*, and becoming well-rounded pads, they traverse the tuberosities of the ischia, pass between the thighs, and thence perpendicularly to the horizontal iron rod or *crossbar* *L*. The crossbar *L* is supported at each end by a perpendicular bar extending upwards from the platform *D*. Attached by one extremity to the crossbar *L* is a rod *P*, running parallel with and situated directly above the thigh. The other end of this rod *P* is supported by an arched iron bar *N*, extending upwards from the outer side of the long splint *J*. The rod *P* is designed to afford special support to the injured limb whenever such support is deemed advisable. Two or three strips of cotton cloth, of suitable width, may be passed around the limb, either internally or externally to the splints of coaptation, and tied over the supporting rod *P*. Splints of coaptation are to be applied according to the exigencies of the case.

Fig. 401.



Sanborn's apparatus.

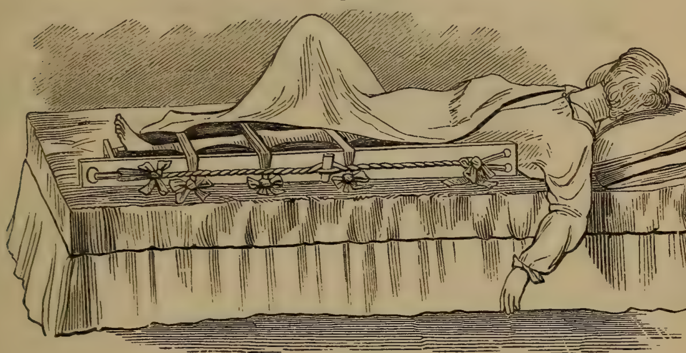
"*M*, an inside splint covered by the bandages. *Q*, the screw by which extension is effected in the ordinary way, having at an extremity a swivel and hook, tied to a strip of wood in the loop of adhesive plaster below the foot."

In the apparatus of Sanborn, of Lowell, Mass. (Fig. 401), there is only the long splint used. It projects as far as the axilla, where it supports a crutch (*a*) moved by a screw (*b*); the lower end bears a bar of iron (*c*), projecting at right angles, and also movable by a screw (*d*). In applying this splint, two long strips of adhesive plaster are laid upon the sides of the leg, extending from above the knee to a point two or three inches beyond the foot, and secured by a roller. The ends of the strip form a loop to catch upon the cross-bar, and by means of the screw extension can be regulated at will. The counter-extending band is put on in the usual manner, and it is intended by the crutch arrangement that, should the band press hurtfully upon the perineum, it may be temporarily discontinued, and the counter-extension established in the axilla.

Practically, this cannot be continued effectually for any lengthy period, for it is instinctive on the part of a patient, in order to avoid this axillary pressure, and especially when it galls at all, to twist the shoulders to the opposite side, and thus destroy the counter-extension.

Dr. Neill, of Philadelphia, has employed a contrivance, by means of which extension and counter extension may be sustained at the same moment. The peculiarity of the arrangement consists in the

Fig. 402.



Neill's apparatus.

extending and counter-extending bands being attached to a double cord passing along the outside of the long splint, and which can be shortened at pleasure by twisting them by a short peg placed between them at their middle; this apparatus is not unlike one described by Du Verney.

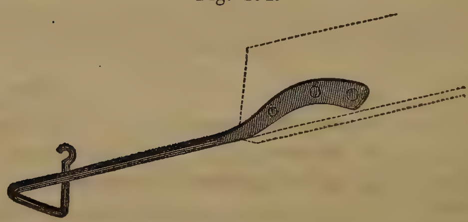
In some cases of fractured thigh it will be found necessary to dispense with the perineal band altogether, and then the surgeon will find in the adhesive strips an invaluable resource in making counter-extension. The peculiar plan now to be described was introduced into the Pennsylvania Hospital by Dr. H. L. Hodge, and found to be effective in the cases in which it was tried. I have employed it in several instances with gratifying results; it enabled me to keep up efficient counter-extension, while the adhesive strips about the chest did not in the least inconvenience the patient further than the application of an apparatus requiring continuous dorsal decubitus; nor did it impede respiration.

In Figs. 403, 404, it will be seen that the apparatus consists of an ordinary Desault's splint, wide enough at its upper end to permit the iron bar, fastened by bolts to its superior edge, to pass clear of the patient's shoulder. The bar itself is bent at right angles, as seen in Fig. 404, over the shoulder, so that the hook at its extremity may come in the line of the axis of the injured limb. A broad strip is now applied upon the anterior face of the chest from the groin to the shoulder, where a loop is left, and then continued down the back to the nates; in the loop a small block is placed to keep the two parts of the strip separate, and also from wrinkling, that they may draw upon the body in parallel lines. The block is connected to an iron

hook by a cord. In order to prevent the vertical strip slipping upwards by the tractile force, three circular strips are applied to the chest, as seen in Fig. 403.

Fig. 403.

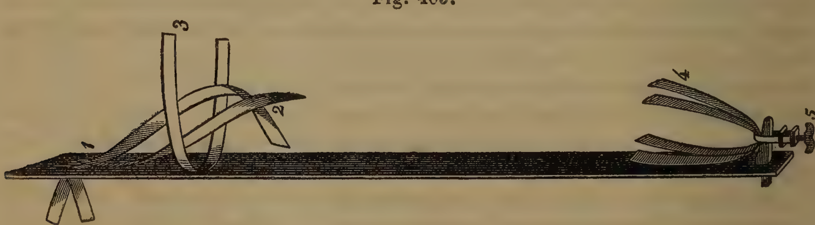
Fig. 404.



Hodge's apparatus for counter-extension in fracture of the thigh.

Dr. Gilbert, of Philadelphia, has recommended the substitution of adhesive strips for the ordinary band used in making counter-extension. Fig. 405 shows his splint with the adhesive strap attached.

Fig. 405.

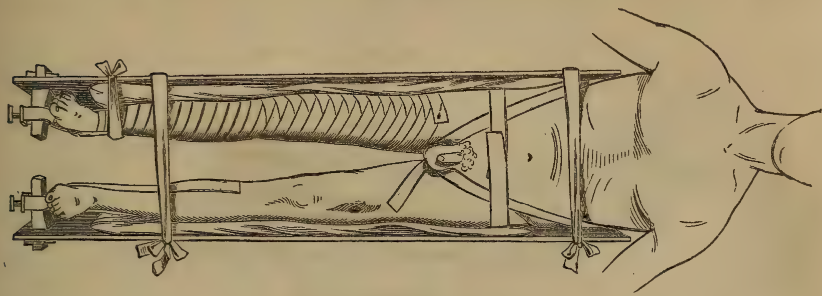


Gilbert's mode of counter-extension.

Fig. 406 illustrates its mode of application in a case of double fracture of both thighs: 1, is the anterior counter-extending strip, two and a half inches wide; 2, the end of the posterior strip, which is brought up in front; 3, a pelvic adhesive strip, three inches wide, which serves to bind the two former strips to the body; 4, the extending strips, which form a stirrup under the foot to receive the strap of the tourniquet; 5, the tourniquet, for applying the extending power. The side-splints are applied in the usual manner with cush-

ions, &c., as seen in the figure. After the application of the adhesive strap a bandage is applied from the ankle upwards.

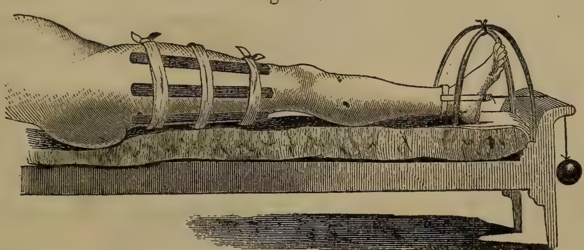
Fig. 406.



Gilbert's apparatus applied.

Dr. Dugas, of Georgia, applies a weight to the limb for the purpose of making extension, and directs his apparatus to be applied in this manner: "Suitable compresses having been placed upon the thigh, apply over them four wooden splints a little longer than the femur

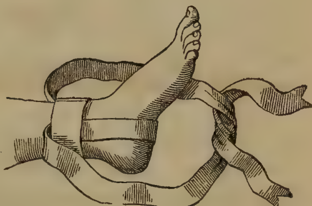
Fig. 407.



Dugas' apparatus applied.

(one in front, one in the rear, and one on either side), and secure them with many-tailed bandages or with single ties. A two or three-pound weight should then be fixed to the foot, and hung over the footboard of the bed, as indicated in Fig. 407, so as to keep up extension, while the resistance of the patient's body will effect counter-extension. A splint four inches wide, and extending from the side of the thorax to a little below the foot, will now serve to keep the limb straight, and to maintain the foot in a proper position. This splint should be secured by separate ties passed around the abdomen, pelvis, thigh, leg, and foot. Finally, an arch of crossed hoops should protect the toes from the bedclothes.

Fig. 408.



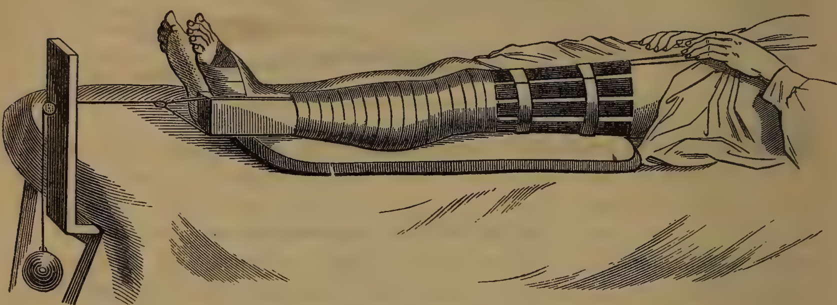
Dugas' mode of attaching the extending band.

Fig. 408 shows the manner in which Dr. Dugas attaches the extending band to the ankle.

Dr. Gurdon Buck, of New York, makes extension with adhesive

strips, connected with a weight varying from five to twenty pounds. The counter-extending band is composed of an India-rubber tube, an inch in diameter and two feet long, stuffed with bran or cotton lamp-wick, and covered with Canton flannel. As seen in Fig. 409, he dis-

Fig. 409.



Dr Buck's apparatus.

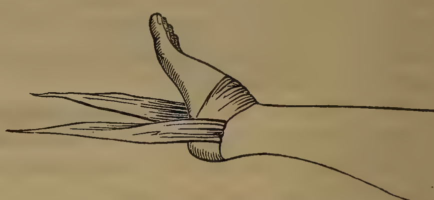
cards the long splint, the limb being simply enveloped in a roller bandage, and short splints applied to the leg.

The methods of making extension with the gaiter and cravat, formerly used (Figs. 410, 411), have, of late years, been happily dis-

Fig. 410.

Mode of making extension with the gaiter.

Fig. 411.



Mode of making extension with the cravat.

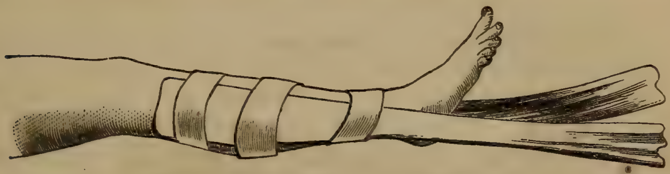
carded; adhesive strips are now employed for this purpose, and the advantages over the former are incontestable, among the chief of which may be mentioned the simplicity of the plan, and the requisite amount of force being attainable without inflicting injurious pressure upon the insteps and margins of the foot.

Two broad strips should be cut in the length of the plaster, and well stretched, so that they may not yield when applied to the leg, and the extending force is exerted; they must reach well up the limb to get a good purchase, and have circular strips of the same material and a roller bandage laid over the whole, as seen in Fig. 412.

M. Gariel, who has been instrumental in applying India-rubber to so many useful surgical purposes, advises, in treatment of fractures, the use of elastic extending and counter-extending lacs. His apparatus, as described by Jamain, is composed, 1st, of a sort of stirrup in the form of a circular sac embracing the ankle, and shaped in such a manner that when it is inflated, it is converted into a cushion exactly

moulded to the limb, in contact with the latter at every part of the surface, and consequently exercising a perfectly uniform pressure.

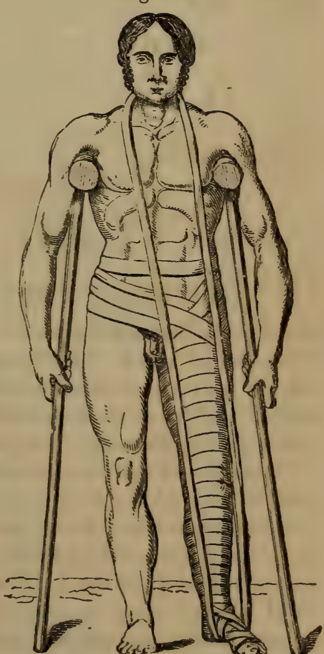
Fig. 412.



Mode of making extension with adhesive strips.

This can be rendered still more gentle by the application, around the extremity of the limb that supports the extending stirrup, of a roller which possesses the double advantage of preventing the swelling of the foot, and the immediate compression of the tissues by the apparatus. The traction is effected by means of two extensions of the stirrup, strong cords, which, although flexible, and especially eminently retractile, stretch sufficiently without losing their capacity for contraction, and thus assuring a continuous and perfectly exact traction; 2d, of a counter-extending lac, a tube of India-rubber about thirty-nine inches long, presenting at its middle point an enlargement destined to exercise pressure upon a wider surface. This enlarged portion ought to be placed upon the groin of the side of the fracture, and extend just beyond the perineum. The extending cords are attached to the lower part of the bedstead.

Fig. 413.



Mode of applying the starched bandage in fractured thigh.

Mr. Erichsen says that the starched bandage may be employed in most cases of fracture of the shaft of the femur, and that with the apparatus seen in Fig. 413 he has treated many such cases, both in adults and children, without confinement to bed for more than three or four days, and without the slightest shortening or deformity being left. His manner of proceeding is described by him thus: "A dry roller should be applied to the whole of the limb evenly and neatly, which must then be covered with a thick layer of wadding; a long piece of strong pasteboard, about four inches wide, soaked in starch, must next be applied to the posterior part of the limb, from the nates to the heel. If the patient is very muscular, and the thigh large, this must be straightened, especially at its upper part, by having slips of bandage pasted upon it. Two narrower strips of pasteboard are now placed along either side of the limb from the hip

to the ankle, and another shorter piece on the forepart of the thigh. A double layer of starched bandage should now be applied over the whole, with a strong and well-starched spica. It should be cut up and trimmed on the second or third day, and then reapplied in the usual way."

This method of treatment will require the greatest watchfulness by the surgeon, to see that no danger comes of constricting the limb, either from the subsequent swelling, or from too tight application of the roller bandage. Apparatus of the same description have been recommended by Seutin, Larrey, and Velpeau, as already described.

In whatever way a fracture of the shaft of the femur is managed, it demands the daily surveillance of the surgeon; any injurious pressure of the splints upon the bony prominences of the limb must be corrected by shifting the cushions, introducing compresses between the limb and the splints, and the frequent application of stimulating washes, of which one of the best is the camphorated tincture of soap.

The patient must be kept in the apparatus seven or eight weeks, though in some cases the removal may be made safely at an earlier period; or, on the other hand, require it to be delayed beyond the time stated above.

At first the extension should be gradual, and, in proportion to the capability of the patient to bear it, it must be increased to the fullest extent required, which perhaps may be accomplished in six or eight days. When the case has progressed favorably, the extending bands may be removed in four or five weeks, and the long splint, with a footboard attached, only retained, which will hold the limb securely until the consolidation becomes firm enough to support the weight of the body. At this time—in about eight weeks—the patient will be permitted to rise and go about upon crutches for two or three months, when they may be laid aside.

With a careful patient, I have sometimes removed the straight splints in two weeks and applied the starched bandage, and permitted him to go about.

3. *Fracture of the Condyles of the Femur.*—The condyles may be separated from the shaft of the femur at their base, or, at the same time that they are separated thus, another line of fracture passes between them. Other instances are recorded where one or the other condyle alone is broken from the shaft.

Causes.—This injury is produced by the application of great violence, falls or blows upon the knee, the passage of the wheel of a cart over the part, &c.

The displacement, if the fracture is oblique, will always be of the lower fragment backwards; on the other hand, this may be very little in transverse fracture. In separation of the condyles, lateral displacement occurs.

Symptoms.—Preternatural mobility at the seat of fracture; the alternate flexion and extension of the leg will produce crepitus; shortening. When the condyles are separated from each other, they may be seized upon each side with the fingers, and moved in opposite directions, the motion producing crepitus; shortening will be mani-

fest; the knee-joint appears to have widened out, and the patella depressed between the condyles.

Prognosis.—These fractures will generally be attended with violent inflammation in or about the knee-joint, rendering the case always serious. Anchylosis will perhaps be one of the most favorable results that can be obtained. More or less shortening must be expected.

Treatment.—In fracture of either condyle, the limb may be placed in a straight position, and pasteboard or gutta-percha splints applied and secured with a roller.

When the condyles are separated from the shaft, or from the shaft and each other, moderate extension will be required upon the limb, placed either in the flexed or straight position, some surgeons preferring the former, and others the latter; whichever plan is selected, the apparatus previously described will supply the means to carry it into effect.

Fracture of the Patella.—Fracture of the patella is not uncommon; the bone is generally broken in a transverse direction (Fig. 414), though the line of fracture may be vertical, or again run in two or three directions so that the patella will be divided into three or more pieces. (Fig. 415.)

Causes.—In the first instance, the cause of the fracture is most commonly violent muscular effort, as when a person falling backwards endeavors to save himself by a great effort, or in jumping or kicking; the transverse fracture also results from blows. Longitudinal and comminuted fracture is, in a majority of instances, the result of some direct injury, and is attended with much swelling, pain, and inflammation about the joint.

Fig. 414.

Fig. 415.

Fracture of the patella.

The displacement observed is a separation of the upper from the lower fragment, which retains its position in consequence of its connection with the tibia by the ligament of the patella. The direction of the displacement is upwards, and varies in amount from a few lines to four inches or more, according to the extent to which the aponeurosis connected with it is lacerated.

Symptoms.—This injury is of easy recognition. The upper fragment can be felt to be drawn up, leaving a depression between it and the lower one in which the finger may be placed. If the fragments can be brought into apposition, crepitus may be developed by rubbing them together. The patient, at the time of the injury, will feel a crack, perhaps in the knee, and find himself unable to stand upon the limb, or to extend the leg.

Prognosis.—Union in fractured patella occurs almost always by ligament, in rare instances that by bone has been observed. The recovery will commonly take place without any further difficulty than perhaps a little stiffness of the knee, which gradually disappears. It has been noticed that when the separation between the fragments is considerable, and connected by a long ligamentous band, the limb in the exercise of its functions will be impaired a long time, but will ultimately be restored to the full possession of its motions.

Treatment.—The treatment of fractured patella consists in subduing local inflammation, restoring the fragments in apposition, and maintaining them in this position by appropriate mechanical means, until the union has been effected.

The first indication is answered by the use of leeches and cold applications. The third indication will be fulfilled by the employment of certain apparatus, of which there are a large number, recommended by various surgeons.

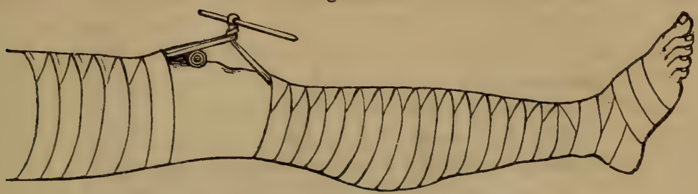
Mr. Liston recommended a very suitable contrivance. The foot and leg, to a point just below the knee, are enveloped in a roller bandage to prevent swelling; the limb placed upon a padded splint, hollowed at both ends, reaching from the tuberosity of the ischium to a point a little below the middle of the calf; after bringing the upper fragment down to its normal position, a roller is passed around the limb and the splint from the toes to the groin, making several crosses at the knee. Mr. Amesbury employed soft padded leather bands, long enough to go half around the limb, and having straps and buckles attached to their ends, by means of which they were confined to the limb, one upon the lower part of the thigh, and the other upon the leg below the knee. To the lower margin of the upper band a buckle is attached upon each side of the patella; corresponding to these buckles two straps were fastened to the upper margin of the lower band. By approximating the borders of the bands, the upper fragment is drawn down towards the knee.

Instead of the wooden splint of Liston, Dr. Gross, of Philadelphia, recommends the employment of a padded tin case, extending from the middle of the thigh to a corresponding point of the calf. A roller is to be applied upon the leg from the toes upwards, and another upon the thigh from the groin downwards; the displaced fragment is to be brought down, and confined by numerous adhesive strips, carried around the bone above and below the joint, and connected afterwards by vertical and transverse pieces. A long, thick, and very narrow compress should extend around the upper border of the patella, and confined by the two rollers passed around the joint in the form of the figure of 8.

Dr. Sanborn, of Lowell, Mass., suggests a way of treating a fractured patella by a single adhesive strip twisted above the knee. He directs "a strip of ordinary adhesive plaster, four feet long and two and a half inches wide, to be applied to the limb from the upper portion of the thigh to the middle of the leg, leaving at the knee a free loop (Fig. 417). A roller bandage is then applied above and below the knee, for the purpose of securing the plaster, and controlling the circulation and mus-

cular contraction. A small stick six or eight inches in length then being put through the loop over the knee, the plaster is to be twisted

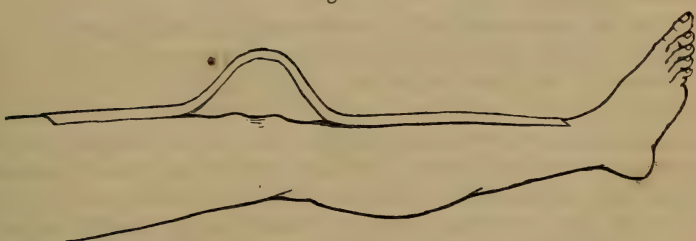
Fig. 416.



Sanborn's apparatus applied.

until the patella is brought near down to its proper situation. Before applying the *twist* a hard compress is to be placed above the patella

Fig. 417.

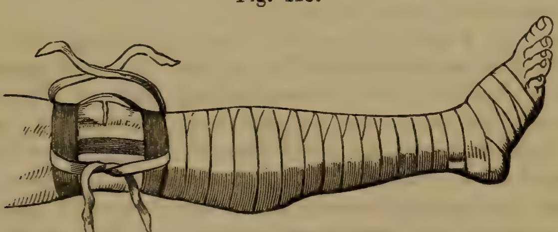


The same.

in such a manner as to bring the force to bear directly upon the bone." (Fig. 416.)

One method pursued by Sir A. Cooper is seen in Fig. 418. He recommended that the limb should be lightly bandaged to a splint

Fig. 418.

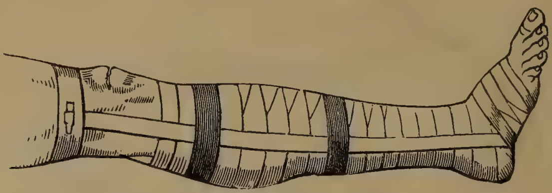


Sir A. Cooper's apparatus.

extending from the ischium to the heel, leaving the knee uncovered; the thigh is then to be flexed upon the trunk, and the limb reposed upon an inclined plane, while the antiphlogistic remedies are to be had recourse to until the inflammatory swelling shall have abated. Then a roller is to be applied to the leg, from the toes to the knee, to prevent engorgement; upon each side of the limb a strong tape is laid and confined above and below the knee by a roller bandage; their extremities are now to be drawn together and tied. Sometimes a band is put in front of the knee, and arranged in the same manner.

The same distinguished surgeon describes another apparatus (Fig. 419) for the same purpose. A leather belt surrounds the lower part

Fig. 419.

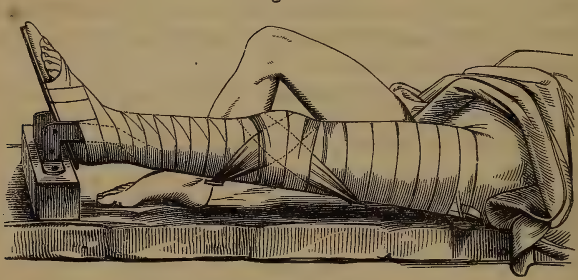


Sir A. Cooper's apparatus for fractured patella.

of the thigh above the upper fragment. To the side of this a long strap is attached which is intended to pass beneath the sole of the foot, up the opposite side of the limb, to be buckled to the thigh-belt; tapes secure the strap from slipping from the leg. As in the other contrivance, a roller bandage is to be previously applied to the leg.

Mr. John Wood, of London, contrived the apparatus seen in Fig. 420. It consists of a long splint extending from the tuberosity of the

Fig. 420.



Wood's apparatus.

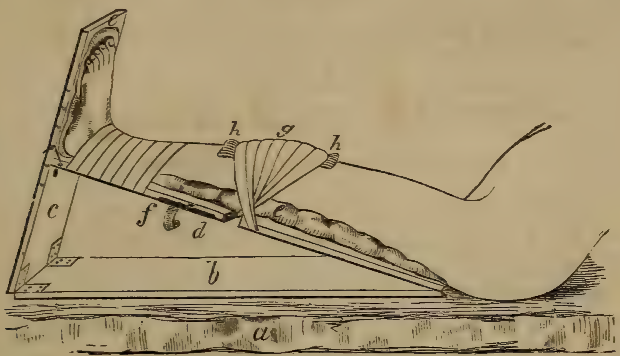
ischium to within a short distance of the heel; from the end of this two short lateral curved iron bars extend, supporting a footboard, and bent at right angles to be fixed to a block which raises the splint from the bed. To each side of the splint two hooks are fastened, one above the knee and the other below.

In applying the apparatus the splint is well padded and the limb laid upon it; a roller bandage is now applied from the toes upwards, arriving at the knee, after the fragment has been drawn down, the roller is made to form a figure 8 about it, the turns of which are prevented from slipping by the hooks.

Prof. Hamilton has adopted a much better form of splint than the preceding, and one I have used in three cases with decided success. It is seen in Fig. 421, and he describes it in the following language: "The dressing consists of a single inclined plane, of sufficient length to support the thigh and leg, and about six inches wider than the limb at the knee. This plane rises from a horizontal floor of the same length and breadth, and is supported at its distal end by an

upright piece of board, which serves both to lift the plane and to support and steady the foot. The distal end of the inclined plane may be elevated from six to eighteen inches, according to the length of the limb and other circumstances. Upon either side, about four

Fig. 421.



Hamilton's apparatus.

inches below the knee, is cut a deep notch. The foot-piece stands at right angles with the inclined plane, and not at right angles with the horizontal floor; it may be perforated with holes for the passage of tapes or bandages to secure the foot.

"Having covered the apparatus with a thick and soft cushion carefully adapted to all the irregularities of the thigh and leg, especial care being taken to fill completely the space under the knee, the whole limb is now laid upon it, and the foot secured gently to the footboard, between which and the foot another cushion is placed.

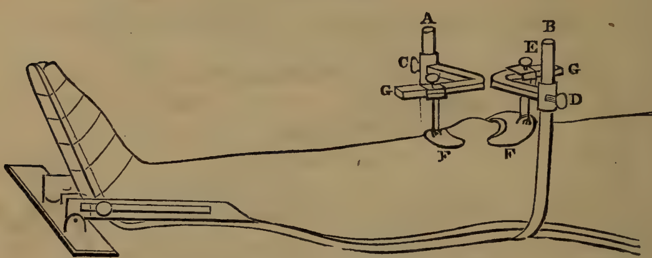
"The body of the patient should also be flexed upon the thigh, so as the more effectually to relax the quadriceps femoris muscle.

"A compress made of folded cotton cloth, wide enough to cover the whole breadth of the knee, and long enough to extend from a point four inches above the patella to the tuberosity of the tibia, and one-quarter of an inch thick, is now placed on the front of, and above the knee. While an assistant presses down the upper fragment of the patella the surgeon proceeds to secure it in place with bands of adhesive plaster. Each band should be two or two and a half inches wide, and sufficiently long to inclose the limb and splint obliquely. The centre of the first band is laid upon the compress partly above and partly upon the upper fragment, and its extremities are brought down so as to pass through the two notches on the side of the splint and close upon each other underneath. The second band, imbricating the first, descends a little lower upon the patella, and is secured below in the same manner. The third, and so on successively until the whole extent of the compress and knee is covered, is carried more nearly at right angles around the leg and splint; the last bands passing obliquely from below the ligamentum patellæ upwards and backwards. The dressing is now completed by passing a cotton roller around the whole length of the limb and splint, commencing at the

toes and ending at the groin. This is applied lightly, as its object is only to support and steady the limb upon the splint." The superiority of this apparatus is that it does not obstruct the circulation by constricting the limb, as there is ample space between the bandage and sides of the limb.

A rather complicated apparatus was employed by Mr. Lonsdale, but it has the recommendation of being efficient (Fig. 422).

Fig. 422.

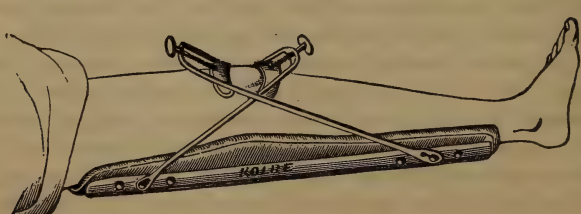


Lonsdale's apparatus for fractured patella.

It consists of a well-padded splint extending along the posterior surface of the limb, and supporting at its further end a footboard which may be moved up or down to accommodate the splint to limbs of different length. From the bottom of the splint in the neighborhood of the knee-joint two vertical metallic bars, A B, project, each bearing an iron stem, G G, bent at right angles moving upon it, and capable of being fixed at any point by the thumb-screw, C D—the two portions of the stems in the axis of the limb support sliding pins having attached to their inferior extremities padded metal plates of a semilunar shape, intended to press upon the fragments above and below. In employing the apparatus the limb is laid upon the splint and secured to it by a roller bandage, and after the upper fragment is drawn down the semilunar pads are placed against the upper and lower borders of the patella and fixed by the screws. To relax the quadriceps femoris, the lower end of the splint is raised from the mattress upon a little frame.

Surgeon P. Lansdale, U. S. Navy, has invented a very ingenious and efficient splint seen in Fig. 423. It holds the fragments in exact

Fig. 423.



Lansdale's apparatus.

apposition, and does not constrict the limb. It is constructed with a posterior padded splint upon which the limb is secured with a roller

bandage. From a point a short distance above the knee an iron loop or arc spans the limb obliquely, and, when in position, its top is below the patella; a similar arc is fastened to the splint at a corresponding point below the knee, and its top, when in position, is above the knee. Each of these arcs bears a screw at its centre armed with a semilunar pad. In the application of this apparatus after the limb is secured to the splint, it is simply necessary to bring the upper fragment down, and with the upper screw clamp the pad against it; in like manner clamp the inferior fragment with the lower pad. This holds the pieces of the patella firmly together so that it is impossible for them to escape.

M. Malgaigne, struck by the general inefficiency of the apparatus employed in France for fractured patella, devised the instrument seen in Fig. 424. It consists of two pairs of sharp-pointed hooks movable towards each other by a screw, and intended to take their *point d'appui* directly upon the bony fragments above and below.

Fig. 424.

Malgaigne's apparatus for fractured patella.

In applying the instrument the hooks are thrust through the skin down to the margins of the fragments, and by the action of the screw these are brought into close contact and retained in this position six weeks, or until their union is accomplished.

I have employed Malgaigne's apparatus in one case with decided success; and there were no troublesome symptoms presented during the treatment, which, I must confess, at first, I feared would occur from the proximity of the hooks to the knee-joint.

A very simple but efficient application of the Spanish windlass or handkerchief and stick arrangement to the back splint, in the treatment of transverse fracture of the patella, is recommended by Dr. Edward Hartshorne, who has employed it with great advantage in hospital and private practice, having used it first in the Pennsylvania Hospital in 1862.

The splint, which should, of course, be carefully padded, is not peculiar, except that, in accordance with an old rule, it is always broad enough above and below the knee to prevent the bandages from constricting or pressing on the sides of the limb in their passage backwards from the margins of the patella; and is also furnished on its sides, at proper distances, above and below the knee, with the notches or projecting cleets, pins, or hooks which are required to hold the bandage. This bandage may be the common roller or adhesive strips, or even a band or ring of elastic webbing; but inelastic webbing, or linen, or cotton drilling from one and a half to two inches wide in the central portion and narrower at its ends, answers better, especially if the surfaces which we apply to the integument above and below the fragments are thinly spread with old adhesive plaster. The lower fragment is fixed in the usual way, and retained in position by simply applying one of the bandages by its wider central portion in front of

the knee-joint directly to the lower margin of this fragment, then passing the two narrower ends obliquely upwards and backwards and drawing them firmly together over the upper cleets, pins, or notches, and behind the splints, there to be fastened in any manner most convenient.

The bandage or band for the upper fragment requires more careful application and adjustment, as it is to exert all the pressure and traction force necessary to bring the fragment down, and retain it in apposition with the fixed lower fragment. Having been applied to the integument just above and slightly over the margin of this upper fragment, it is then drawn firmly downwards and forwards over the notches or cleets in such an oblique direction as may be found the best for efficient traction in each particular case. The two ends are firmly fastened together, and a small stick (or, what is better, the little wooden fork called a clothes-pin), passed between the band and the splint, is turned or twisted on its long axis in such a way as to draw upon the bandage to any proper extent. This arrangement allows the whole knee, especially the injured parts and the compressing bandages, to remain uncovered, at the same time that it gives entire control of the joint and of the separated fragments, as well as of the dressing itself. Compresses of lint or other material may be employed, but they are not often needed, particularly when adhesive plaster is spread upon the central portion of the bandage. Tilting of the fragments may be prevented by a transverse bandage, or by a narrow, well-padded transverse splint pressing upon the line of fracture. The ease and certainty with which the traction may be lessened or increased by the slightest turn of the twisting-stick or pin, at the same time that this pin may be fastened beyond the reach or control of the patient, renders this contrivance remarkably effective; while the simplicity of materials and arrangement bring it readily within the reach of every one. The same care in all essentials, and especially in adapting the splint and bandage, as to length and width of the former, and the distance apart of the cleets or notches, and the width and obliquity of the latter, must be observed in the use of this mode of dressing, as in other more complex or different arrangements. Dr. Hartshorne's method has been tried sufficiently often under his own observation, to satisfy him that it works well in every respect; having been found very comfortable to patients, even after considerable inflammation of the soft parts, and under long-continued, close approximation of the fragments; requiring less attention than usual in maintaining the adjustment; and being followed, in several instances, by inappreciable separation, if not actual consolidation.

Various contrivances for graduating traction behind the splint, or on its sides—such as wedges, screws, buttons, elastic rings or straps, as well as neater forms of wooden or metallic, and guttered splints in the usual shapes—might be suggested; but they are all objected to by Dr. Hartshorne, on account of their complexity and costliness, from which his bandage and stick are free.

To meet the desire for a more convenient and comfortable dressing, especially during convalescence, and in case of injurious separation

of the fragments from defective treatment, he has, with the aid of Mr. Kolbe, devised a light tin case, fitting to the limb behind, lacing in front of the thigh and the leg, and being provided with straps (elastic or not, according to circumstances), which are to be applied, as usual, across the joint, above and below the patella, and drawn obliquely to be fastened and tightened by means of a wedge or screw. Such an apparatus, properly made, would be found very convenient to those in whom the treatment is sufficiently advanced to admit of moving about, as well as to all patients who are willing to indulge in the expense of an unnecessarily luxurious kind of splint.

Dr. Hartshorne has applied the same dressing in a still simpler form, with entire success, to the treatment of fractured olecranon. In this fracture, as in the other, the splint must be wide enough below the elbow-joint to avoid constriction, and but one bandage and one set of notches or projecting cleets are needed. The application of the bandage, which is evident enough, has been found to work admirably. The Spanish windlass may be usefully resorted to, as it doubtless has been, in the production of compressing force for different purposes in other parts of the body. Dr. Hartshorne has found it an excellent substitute for Malgaigne's screw-pin and collar in managing the troublesome displacement of the lower fragment in oblique fracture of the tibia. With a sufficiently wide and well-padded splint, and a judicious employment of compresses, he has been able to effect very nearly, if not quite as much by means of the bandage and stick, as can be done either with the saddle-shaped pads, with which Dr. Prince has improved upon the pointed screw of Malgaigne, or with the latter more formidable instrument.

The foot ought to be supported, at least in the early stages of treatment of fractured patella. It may be effected either with a long splint furnished with a footboard, with a fracture-box or trough, with a footboard attached to the bedstead, or with plenty of pillows. This support is not indispensable, but it is advantageous and comfortable.

In carrying out the mechanical treatment of fractured patella, Dr. Hartshorne has secured, by his apparatus, several important advantages. He avoids circular and lateral constriction, keeps the parts in view uncovered and cool, with room for lotions, if desirable, and produces and maintains ample traction in a sufficiently effective direction, taking care to prevent tilting, and to cause a close approximation of the fractured surfaces, all with the simplest possible means and materials. He does not elevate the extremity, nor very strongly extend the leg. Both of these positions, elevation and extension, are uncomfortable, fatiguing, and unnecessary.

In fracture of the patella it will be necessary to continue the splint seven or eight weeks, at the lapse of which time daily passive motion must be inflicted upon the knee-joint. The patient may be permitted to get up and go about on crutches, but, in order to avoid stretching of the ligamentous band, the limb should be kept extended by a straight splint applied to its posterior surface for two or three weeks more.

Fracture of the Tibia and Fibula.—Fracture of the tibia and fibula constitutes more than half the cases of this sort of injury affecting the bones of the leg. It is here that we meet with a large proportion of compound and comminuted fractures. Both bones may be broken at the same or different heights; in the first instance (Fig. 425)

Fig. 425.

Fig. 426.

Fractures of the tibia and fibula.

the fracture will be found usually located at the junction of the upper with the middle third, and in the latter the tibia will usually give way in the lower third and the fibula in its upper, as seen in Fig. 426.

The line of fracture is, in a majority of cases, oblique, yet it is sometimes transverse, and will then occur usually at some point in the upper third of the tibia; the fracture of the fibula is almost always oblique.

Causes.—The commonest cause of fracture of the leg is the application of direct violence, as the fall of a heavy weight upon the limb, the rolling of the wheel of some sort of vehicle over it, heavy blows, &c. Again, a person's weight coming upon the soles of the feet in jumping from a height will also produce the fracture. It is in those cases from direct injury that fracture of both bones at the same level is commonly observed, and the reverse in fracture from contrecoup.

The nature of the displacement will depend upon the direction of the line of fracture and the sort of force producing it. When the line is transverse, there will be little else than perhaps some lateral deflection of the ends of the fragments in opposite directions, and the limb not shortened. When it is oblique, which it generally is, and in a direction downwards and forwards, the lower fragment will be drawn

upwards by the muscles of the calf of the leg, and thus produce slight shortening. In this instance the top of the superior piece will project in front beneath the skin, sometimes will perforate it, rendering the injury compound. Angular displacement anteriorly is also seen in certain cases, and is caused by the contraction of the quadriceps femoris or the gastrocnemius, and sometimes by the weight of the foot alone, the former muscle acting with greater energy as the fracture is nearer the knee. Should the foot be twisted inwards or outwards, the lower fragment will be rotated upon the upper.

Symptoms.—The symptoms denotive of fracture of the leg are preternatural mobility at the seat of fracture, deformity when the foot is raised, irregularity upon the anterior border of the tibia and outer edge of fibula when the fingers are run along them, slight shortening, and crepitus evolved by rotating the leg. The patient cannot bear his weight upon the limb, and efforts to do so cause excruciating pain.

Prognosis.—Fracture of the tibia and fibula will generally unite well in about thirty days without any difficulty, while in certain cases it may be delayed a much longer period. Compound and comminuted fractures are liable to become complicated with inflammation and suppuration, erysipelas, necrosis of the ends of the fragments, and in one case I saw tetanus occur on the seventh day and kill the patient. It occasionally happens, in some of these complicated fractures, that a crooked leg will result in spite of the best treatment.

Treatment.—The treatment of this injury has been variously conducted, as regards the position of the limb and the construction of apparatus for retaining the ends of the bones in contact while consolidation is being effected. Most surgeons prefer the straight position of the limb as meeting more fully all the indications presented in this fracture, and either do or do not make extension and counter-extension, according to their views of the necessities of the case.

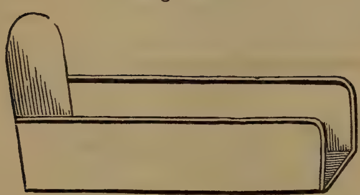
One of the simplest dressings, with the leg in the straight position, and without making extension or counter-extension, is prepared in the following manner: Spread upon a pillow, on which the leg is to repose, a piece of cotton cloth long enough to reach from the lower third of the thigh to the ankle, and sufficiently wide to encircle the limb twice; over this lay as many strips of the same material as will reach from the ankle to the knee, each strip being imbricated and sufficiently long to go around the limb once and overlap two inches upon either side; the leg is now placed upon the dressings, and inclosed by bringing the strips around it in the same manner as in the bandage of Scultetus. Three cushions of oat-chaff or long compresses of lint are placed upon each side and front of the limb, and held in place while an assistant makes extension from the foot, to bring the displaced fragments end to end; the surgeon will then roll up in the splint-cloth, from its ends towards the leg, two splints of the same length as the cloth, and bring them firmly against the cushions, and place a narrow splint in front of the leg; three strips of bandage are now applied, to bind the whole together. To prevent the foot from falling to either side, a cravat may be folded around the foot, and its ends pinned to the splint-cloth. Instead of wooden splints,

wheat-straw may be rolled up in bundles and used for the same purpose as the splints.

This apparatus will be found exceedingly convenient in cases of emergency, and I was in the habit of employing it often during the late war, under circumstances where other more appropriate means were not attainable.

The fracture-box is another simple contrivance, and will be found to answer well in most cases. It consists, as seen in Fig. 427, of an oblong wooden box of four sides, reaching from a little above the knee to the sole of the foot; the lateral sides, six or seven inches wide, are attached to the bottom by means of hinges, which permit them to be raised or lowered, as desired; the fourth side projects upwards, and serves the purpose of a footboard.

Fig. 427.



The fracture-box.

In employing the box, the sides are lowered to a level with its bottom; a pillow is placed upon it, and the leg upon the pillow; extension is now made until the fracture is reduced, when the sides of the box are raised and the edges of the pillow pressed evenly upon the lateral surfaces of the leg. Three strips of bandage are passed around the box, to bind it together, and knotted upon one of its edges; the foot is held to the footboard by a strip of bandage.

If there is any discharge from the leg, to prevent it soiling the pillow, a piece of oiled silk may be interposed between them.

The fracture-box has been highly recommended by Dr. J. Rhea Barton in compound fracture, but he employs, instead of the pillow, a quantity of bran, which should surround and cover the leg. This dressing possesses the advantages of affording the limb uniform support in every direction, does not produce excoriation or ulceration of the heel, and keeps the flies from depositing their ova in the suppurating wound, which they are exceedingly apt to do in hot weather. I used, in the same manner, fine pine sawdust in a case of compound fracture of both legs, and believe it equally as serviceable as the bran, over which it possesses the merit of being more absorbent, and, I believe, forms a cooler bed for the leg to repose in, and does not become sour.

The leg should be inspected daily, and any tendency to angular deformity corrected by proper compresses placed beneath the tendo-Achillis and heel. It should not be forgotten, however, that these compresses may produce injurious pressure upon these parts, and cause ulceration, a result only to be avoided by either removing the pressure entirely, or making it as uniform and soft as possible.

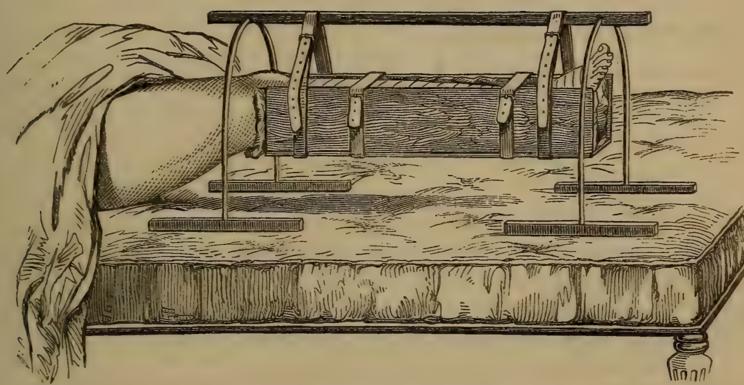
Should it be deemed advisable to make compression upon the leg, or to facilitate the application of lotions of the acetate of lead or other dressings, the bandage of Scultetus, applied directly to the limb, will answer better than anything else.

If the lower end of the upper fragment will project forwards in

spite of these efforts of the surgeon, he will sometimes succeed in keeping it in position by bringing pressure to bear upon it by the tourniquet of Petit, its pad being placed over the bone, and the strap buckled around the box.

After the dressings are applied according to the requirements of the case, some degree of general movement of the leg may be obtained, without affecting the relations of the fragments of bone to each other, by swinging the fracture-box from a horizontal bar supported above it by a frame, as seen in Fig. 428.

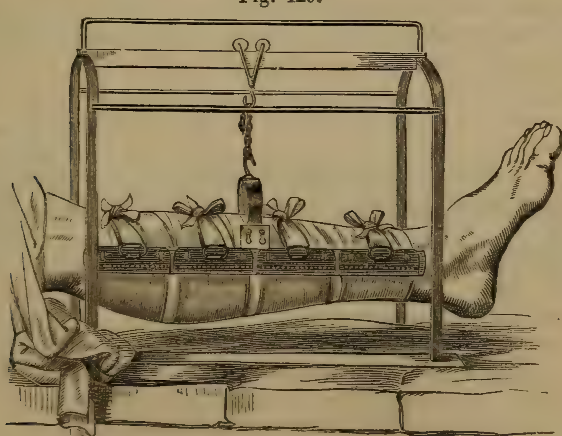
Fig. 428.



Mode of suspending the fracture-box.

A better form of a swinging apparatus is seen in Fig. 429, in which the cradle is supported upon the horizontal bar by two little wheels,

Fig. 429.



Another form of suspensory apparatus for fracture of the leg.

that permit vertical as well as lateral motion, and thus remove the danger of the upper fragment being thrust over the lower.

The "anterior splint" of Prof. N. R. Smith will also be found an

admirable means in many cases of compound fracture of the leg. It permits the seat of fracture to be constantly exposed to the examination of the surgeon, does away with all undue pressure and its results upon the heel, and, lastly, facilitates the cleansing and dressing of the parts.

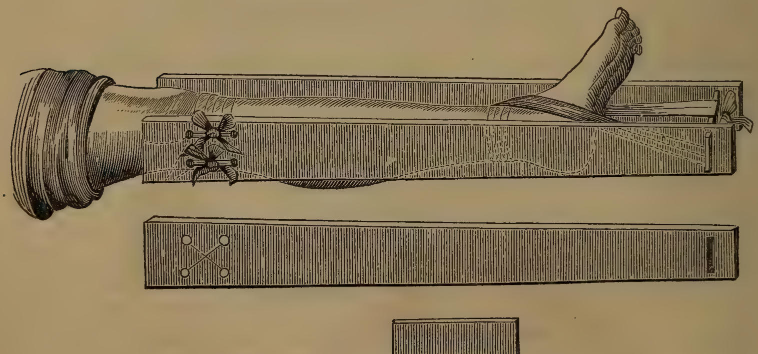
Fig. 430.

Starched apparatus in fracture of the leg.

The starch, gutta-percha, plaster, or dextrine bandage may be employed in simple fracture of the leg after two or three days, when the inflammation and tumefaction have subsided. I usually apply this bandage in almost all cases of fractures of the leg, when the discharge and wounds, if any, have been gotten rid of in other apparatus, and permit the patient to go about upon crutches. For safety, I always use a bivalved apparatus, padded with cotton-batting, and secured to the leg and foot by the roller bandage. In this arrangement the parts may be examined at any time without disturbing the limb, which is permitted to repose in one of the sections while the opposite one is removed.

In those instances of fracture where the fragments persistently overlap, it has been recommended by some surgeons to employ extension and counter-extension. Several plans have been devised for this purpose. Dr. James Hutchinson contrived an apparatus that has been much employed in this country, but now almost abandoned, and very justly, inasmuch as bad consequences were frequently observed to follow the constriction exercised by the band encircling the leg below the knee.

Fig. 431.

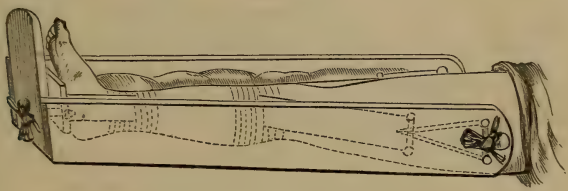


Hutchinson's apparatus for fracture of the leg.

This apparatus consists of two side-splints, extending from a little above the knee to a point three or four inches beyond the sole, connected below by a transverse piece fitting into mortises at their ends. The proximal ends of the splints are perforated with holes for the counter-extending bands. Its application requires the leg to be enveloped in a bandage of Scultetus, and placed upon a pillow; tapes are then laid upon each side of the leg and confined by a roller beneath the knee, and a gaiter placed upon the foot or a cravat made to encircle the ankle for making the extension. Cushions are placed inside of the splints, the counter-extending tapes passed through the apertures in their upper extremities and tied, when the fracture is reduced, and maintained so by fastening the ends of the extending cravat to the cross-bar. Two or three pieces of bandage are now tied around the splints and leg to bind the whole together.

Dr. Neill employs extension and counter-extension in the following manner: "For simple fracture of both bones of the leg, attended with

Fig. 432.



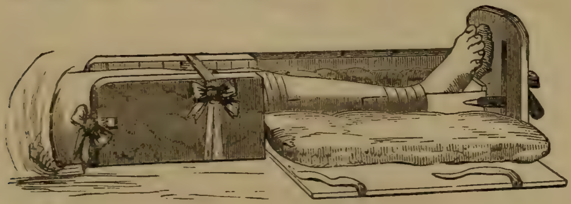
Neill's apparatus for fractured leg.

shortening and deformity, not easily overcome, the limb should be placed in a long fracture-box (Fig. 432), with sides extending as high as the middle of the thigh, and a pillow should be used for compresses.

"The counter-extension is made by strips of adhesive plaster, one inch and a half in breadth, secured on each side of the leg below the knee, and above the seat of fracture by narrow strips of plaster applied circularly. The end of the counter-extending strips may then be secured to holes in the upper end of the sides of the fracture-box, by which the *line of the counter-extension is rendered nearly parallel with the limb*."

Extension is made with adhesive strips in the usual manner.

Fig. 433.



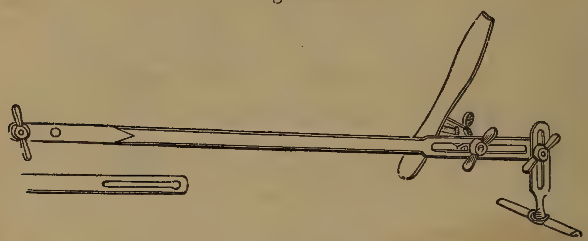
Neill's apparatus for compound fractures of the leg.

In compound fractures, where extension and counter-extension are required, and certain dressings to the injured parts, he employs the

apparatus seen in Fig. 433. It differs from the preceding apparatus, in that its sides are sawn through at the knee, and the lower sections fastened to the bottom by hinges, so that they may be lowered and expose the leg without disturbing the tension of the extending and counter-extending bands.

Mr. Fergusson is very favorably impressed with the utility of an instrument constructed by Mr. Weiss, of London. It yields ample support to

Fig. 434.



Weiss's apparatus for fracture of the leg.

the limb; having a footboard prevents the toes from turning inwards or outwards; is cheap, light, and portable, and with slight modification may be employed in the treatment of fracture of the patella or thigh.

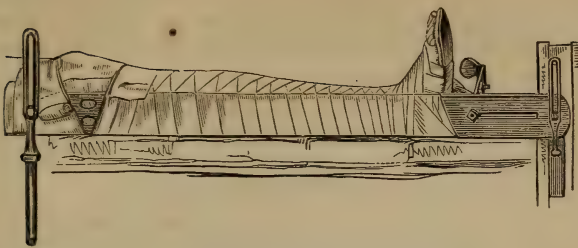
"The bars and foot-piece consist of iron, the screws of brass; the long bar is of an average length, to extend between the knee, and beyond the sole of the foot; the board is so attached that it can be slid upwards or downwards at will, and then be fastened by the side screws; it can also be moved in a lateral direction, so as to evert or invert the toes; and, moreover, it can be placed at such a distance from the splint at the ankle as may be found best suited to the thickness of the patient's limb. The cross-bar below prevents the member from rolling outwards or inwards, and by means of the screw the side-splint and foot may be raised or depressed, as may be found most convenient. The bar may be attached to the screw at the knee, where it will sometimes be found to answer best; or two may be used, one above and one below, each being of service to raise the part over it to any required height. In the cut a small portion of another side-bar is exhibited; this is of the same size and shape as that above described, and is intended to act as a thigh-splint in cases of fracture here, or when it may be desired to apply extension in fracture of the leg."

The accompanying drawing (Fig. 435) shows the manner in which the apparatus is applied. The side-splint is, however, wider than that described above, a modification which Mr. Fergusson has deemed necessary in certain cases.

Dr. Welsh's veneered gutta-percha splints (Fig. 436) for fracture of the leg are also a useful contrivance, giving equable support to the whole leg and foot, and will be found of especial value in those cases of fracture involving the knee and ankle-joints.

Dr. Bauer, of New York, has also devised iron wire splints (Fig. 437), which not only sustains the parts accurately, but, according to this gen-

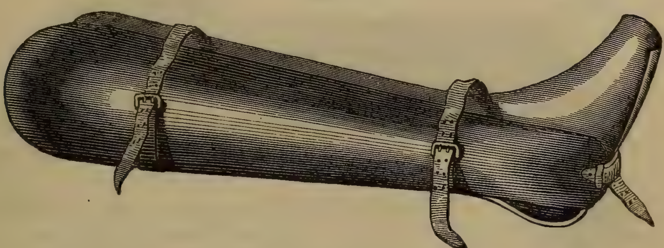
Fig. 435.



Fergusson's modification of Weiss's apparatus.

tleman, possess the further merit of permitting the insensible perspiration to escape freely through its meshes, and allowing the applications

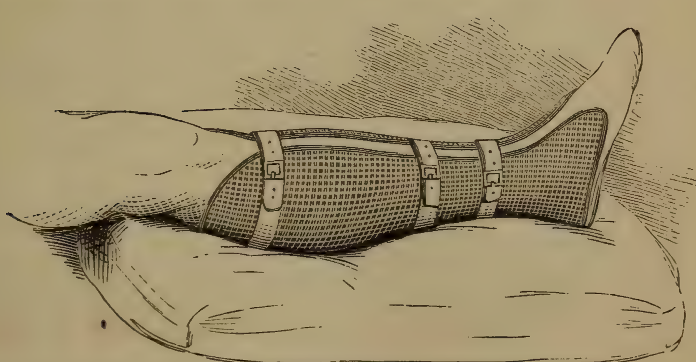
Fig. 436.



Welsh's apparatus for fractured leg.

of water-dressings without impairing the strength of the splint. With proper care, however, application of remedial agents may be made as

Fig. 437.



Bauer's apparatus for fractured leg.

well while using other forms of splints as those of wire—and as these are always covered upon those surfaces in contact with the skin with cotton-batting, or other absorbent materials, the perspiratory secretions are readily taken up.

As the displacement of the fragments results either from the direc-

tion of the line of fracture or muscular contraction, it has been recommended by some surgeons to flex the limb, and thereby relax the muscles causing the displacement, especially when the line of fracture is from above downwards and from before backwards. Mr. Erichsen says, that in these cases the bones may usually be got into excellent position by flexing the thigh well upon the abdomen, and the leg upon the thigh, so that the heel nearly touches the nates, and then laying the limb on its outer side, on a wooden leg-splint, provided with a proper foot-piece, and keeping it fixed in this position.

During the war, a large number of cases of compound fracture of the tibia and fibula coming under my care, I placed five with the leg in a bent position upon Pott's splint. (Fig. 438.) I succeeded well

Fig. 438.

Pott's angular splint for fractured leg.

in keeping the fragments in apposition, and four were cured with an average shortening of half an inch; in the fifth there was no appreciable shortening.

The mode of dressing pursued was the employment of an outside splint about seven inches wide, reaching from above the knee to the sole of the foot, with an angular projection from this point to the tips of the toes to support the foot. This splint was well padded with cotton-batting, with an excavation for the external malleolus, so as to relieve it from all pressure. This was placed upon the outside of the limb so as to bring the inner border of the great toe in line with the inner border of the patella, the thigh having been previously bent upon the abdomen, and the leg at right angles with the thigh; upon the inside of the leg a padded pasteboard splint was put, extending from the knee to the upper border of the internal malleolus; a roller bandage was now applied from the toes upwards, leaving the seat of the fracture uncovered.

If the parts needed support, I used the bandage of Scultetus, applied directly to the leg from the ankle to the knee, and if there was much discharge, I interposed a piece of oiled silk between the limb and splint to protect the latter.

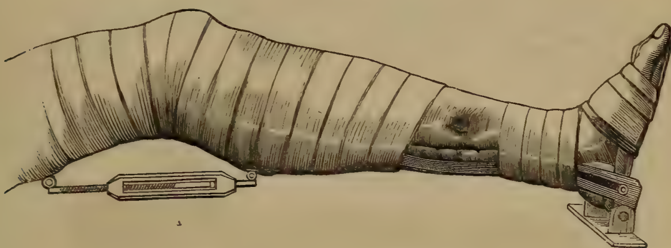
When the apparatus was completed the limb was placed upon its outer side, to which the body was also inclined, though the patients

often changed this position to dorsal decubitus without disturbing the relations of the fragments.

The double-inclined plane, with the footboard attached, already described, may be also employed in the treatment of this fracture.

Mr. Fergusson gives decided preference to the apparatus of Mr. M'Intyre, as modified by Mr. Liston. It consists of a thigh and leg-piece of sheet iron, and a footboard of wood; the former are joined

Fig. 439.



M'Intyre's apparatus for fractured leg.

to each other by a couple of hooks, and a screw, which is so placed that the two plates can be set to any angle at which it may be desirable to bend the knee, and the footboard is affixed in such a manner that it may be slid upwards or downwards to suit the length of the leg, and fastened by a side-screw in any position that may be desired. At the lower end of the machine there is a cross-plate of iron, which is so attached that, in the event of the foot being raised or depressed, it will always rest flatwise on the mattress, or a board placed at the foot of the bed for the purpose of supporting it.

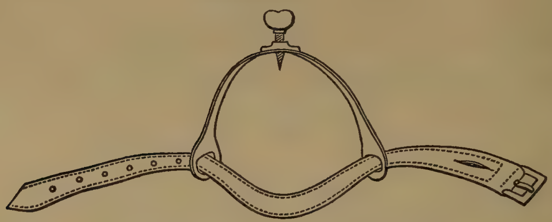
The instrument is applied by placing upon it suitable cushions upon which to repose the limb after the fracture has been reduced; introduce compresses to rectify any malposition of the fragments if that should exist, and to equalize the pressure over the leg; then apply a roller bandage from the toes upwards, leaving the seat of injury increased, if the fracture is compound, and attended with discharge. Extension may be made according to the necessities of the case.

From the construction of this apparatus it may be used either as a straight splint or as a double-inclined plane.

There is sometimes great difficulty encountered, in oblique fracture from above downwards, and from before backwards, in keeping the lower point of the upper fragment in position; it projects beneath the skin, and may perforate it, thus rendering an otherwise simple fracture compound. Malgaigne has proposed an apparatus (Fig. 440) to remedy this. It consists of an arc of steel sufficiently long to span three-fourths of the circumference of the leg; through its centre a sharp-pointed metallic screw works, which also slides in a fenestrum, so that its position may be varied in such a manner that the point may always be forced against the bone perpendicular to the shaft of the tibia. The extremities of the arc have two horizontal mortises for the attachment of a strap. The instrument is applied by placing the limb upon a well-padded

double-inclined plane; the arc is put over the seat of fracture, and then secured in position by the strap buckling around the splint. By

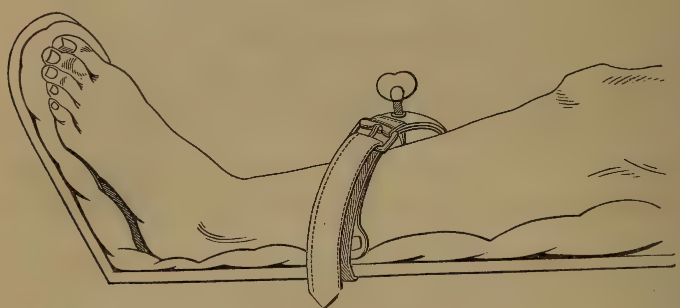
Fig. 440.



Malgaigne's apparatus for fractured leg.

turning the head of the screw the sharp point is pressed against and into the tip of the projecting fragment.

Fig. 441.



The same applied.

Malgaigne says that the patient feels moderate pain at the moment the puncture occurs, but that it soon diminishes. The limb should be kept quiet, and the instrument will remain implanted in the bone fourteen, twenty, and even thirty-six days without determining suppuration, inflammation, or even redness. When the apparatus is removed the puncture in the skin cicatrizes in twenty-four hours.

Fracture of the Tibia. *Causes.*—Fracture of the tibia is generally caused by direct violence, such as heavy blows, the kicks of a horse, &c. The weight of the body coming upon the sole of the foot, as occurs in jumping from a height, is the indirect cause sometimes observed. The point of fracture may be in the shaft or at either extremity; its direction, in the former instance, is ordinarily transverse; in the latter, oblique, and not unfrequently running into the knee or ankle-joints. Fracture of the shaft is seen, in a majority of cases, in its middle third.

Symptoms.—As the fibula remains intact, it serves as a sort of splint to the tibia, so that little or no displacement can occur. The symptoms will be obscure, though, if the case is seen early, some irregularity may be felt upon the surface of the tibia, and perhaps obscure crepitus developed.

Prognosis.—Fracture of the shaft will unite promptly without deformity, while in those cases where the knee or ankle-joints are involved, anchylosis should always be feared.

Treatment.—When the fracture is oblique from above downwards and from behind forwards, penetrating the knee-joint, Sir A. Cooper recommended that, in order to relax the quadriceps extensor, which throws the upper fragment forwards, the limb be placed in a straight position, and a pasteboard splint be applied, embracing the lower third of the thigh, knee, and upper part of the leg.

In the contrary case, where the line of fracture is in a reverse direction, the deformity is caused by the gastrocnemius drawing up the lower fragment, and therefore the limb should be placed upon a double-inclined plane to relax this muscle, while the weight of the leg will act as an extending force. In regard to this latter point, however, it may be added, that extension in these cases is quite unnecessary.

A simple straight splint will usually answer, in a majority of cases, all the indications presented by a fracture of the shaft of the tibia.

An oblique fracture into the ankle-joint, attended with eversion or inversion of the foot, requires the application of a splint in the manner directed for fracture of the fibula, being put upon that side of the limb opposite the direction in which the foot is deflected; that is, if the foot is everted, place the splint on the inside of the leg, and the reverse if it is inverted.

Prof. Gross recommends a tin case, accurately fitting the foot and leg, and extending above the knee. (Fig. 442.) It is padded, and fastened

Fig. 442.

Gross's tin splint.

Fig. 443.

Wire splint.

to the limb by a roller bandage. The wire splint seen in Fig. 443 is also an elegant and efficient contrivance for such cases, and it is the one I am most in the habit of employing.

Fracture of the Fibula.—Fracture of the fibula may occur at any part of its extent, though it is by far most common in the lower fourth. In the upper three-fourths the fragments will be sustained by the tibia, and therefore little displacement can occur. The symptoms are pretty much those of a similar injury of the tibia, and the treatment

Fig. 444.

Fracture of the fibula.

requires the leg to be kept quiet in simple straight splints or a starched apparatus until the consolidation is effected.

In the lower fourth of the bone (Fig. 444) the fracture is quite another thing, both as regards its prognosis and treatment.

Causes.—In the majority of cases the fracture will be found to result from indirect force—falls upon the feet, false steps, &c.; sometimes, also, blows upon the outer edge of the leg will produce the same result.

The mechanism of the fracture depends upon the position of the foot at the time the weight of the body comes upon it, for if this is everted, the os calcis being turned outwards, will press the lower extremity of the fibula upwards, and a fracture will result in the fibula about three inches above the lower extremity; on the other hand, the weight of the body falling upon the inverted foot, will cause the astragalus to rotate outwards against the external malleolus, and break the bone near the same point.

The fracture is usually complicated with a rupture of the deltoid ligament, or a fracture of the lip of the inner malleolus, or a fracture of the entire inner malleolus, the line of separation occurring from without inwards and downwards.

Symptoms.—The symptoms will vary according to the nature of these complications. In the first case, that of fracture of the fibula with rupture of the internal lateral ligament, the pain will be severe, and the ankle much swollen; the patient cannot bear his entire weight upon the foot, which will be slightly everted; a depression will be felt over the seat of fracture, and indistinct crepitus may be evolved by moving the foot. When the tip of the malleolus is broken off, in connection with these symptoms, a depression will exist above the detached fragment. Lastly, in these cases, when the inner malleolus is obliquely fractured, the toes will be everted, the foot much rotated out, and, when grasped in the hand, may be readily moved in any direction, and, at the same time, these motions will emit distinct crepitus. The malleoli will be widely separated, giving the ankle the appearance of an increased width.

Prognosis.—All of these injuries will be attended with more or less stiffness of the joint after the apparatus is removed, which in a few months will generally disappear. In one case that came under my care, where the inner malleolus was also fractured, after the bones had united without deformity, and considerable motion was restored to the joint, the patient could not, at the lapse of nine months, bear his weight upon the foot without the assistance of an apparatus I subsequently contrived for him.

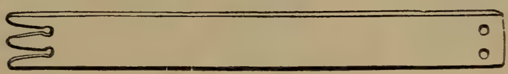
Compound fractures from direct violence frequently require amputation, and will generally result, if the foot is saved, in anchylosis.

Treatment of fracture of the lower fourth of the fibula.—If there is much inflammatory action, lay the leg in an easy position upon a pillow, and apply leeches, cold water-dressings, or other antiphlogistics,

and, when the swelling has abated, apply the apparatus required, of which none are better than that of Dupuytren when the foot is rotated either outwards or, as it sometimes is, inwards. (Fig. 446.)

The splint, which is to be placed upon that side of the limb opposite to that to which the foot is turned, should extend from the knee to four inches beyond the foot, about three wide and half an inch thick; a pad, with the thick end downwards, must be interposed between the splint and leg, and reach from the knee to the upper border of the

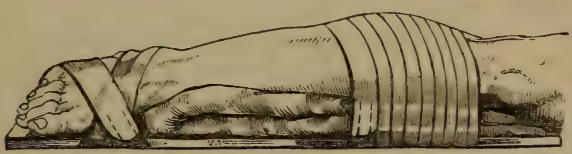
Fig. 445.



Dupuytren's splint modified.

malleolus. With a roller bandage confine the splint to the leg above, and with another roller secure the foot by turns having the form of a figure 8, which will draw the foot in an opposite direction to the displacement, the lower thick end of the pad pressing against the tibia, acting as a fulcrum.

Fig. 446.



Dupuytren's apparatus for fractured fibula.

The form of Dupuytren's splint is somewhat modified, as seen in Fig. 445, by having two retiring angles or notches at its lower extremity, and two holes at the upper one for tapes to pass in fixing the pad to the splint. The difference of its application consists in passing the lower convolutions of the bandage around the ankle and notches.

The apparatus should be removed in three or four weeks, and passive motion impressed upon the joint daily, aided by stimulating and oily frictions.

Fracture of the Tarsal Bones.—The astragalus and calcaneum are sometimes broken by crushing violence applied to the foot, but the former is most often broken by persons falling from a height alighting upon their feet, and the latter by great muscular action, as when a person falling makes violent efforts to save himself, or in jumping.

The other tarsal bones are fractured by the foot being crushed by heavy objects.

The line of fracture may pass through the astragalus in most any direction—antero-posteriorly, horizontally, or transversely. In the os calcis it is seated usually in the neck of the bone, or sometimes beneath the astragalus.

Malgaigne has drawn attention to a species of fracture occurring in

these two bones attended with comminution and impaction of the upper fragment into the lower, causing a separation of the malleoli and an increased breadth of the foot.

From the close connection of the tarsus by ligaments there can scarcely occur any displacement of the fragments except in the calcaneum, when the fracture is seated posteriorly to the lateral ligaments between them and the insertion of the tendo-Achillis, in which instance the posterior fragment will be drawn upwards.

Symptoms.—The parts will generally be found much swollen and painful, the patient cannot stand upon the foot, and sometimes obscure crepitus may be elicited by rubbing the fragments together. If the tuberosity of the os calcis is broken off the connection of the gastrocnemius will draw the detached piece upwards, and the heel will be shortened.

Treatment.—The mechanical requirements in fracture of the tarsus are few; the foot must be placed upon a pillow, and inflammatory action combated by suitable remedies. The displaced tuberosity of the os calcis may be drawn; the leg bent upon the thigh and the foot extended to relax the gastrocnemius muscles, and the slipper of Monroe, described at page 495, applied to retain this position, or the apparatus of Mr. Lonsdale, which consists of a footboard somewhat shorter than the sole, to the distal extremity of which the end of a shoe is nailed to receive the toes; the proximal end has a ring attached with a long strap. The apparatus is applied in this manner: Draw the separated fragment down to the heel; place a compress above, and confine it by a few turns of a roller; now flex the leg, extend the foot, and put on the slipper; carry the strap over the point of the heel up the back of the leg to the inferior part of the thigh, where it is confined by turns of a roller bandage, and reflected upon itself to have a few more turns applied, when the dressing is complete (Fig. 447).

Fig. 447.

Lonsdale's apparatus.

Fracture of the Metatarsal Bones.—These bones can only be fractured by the application of crushing violence; there is usually no displacement of the fragments from their close connection with one another. Sometimes, however, the lower fragments have been found depressed backwards from the force of the injury causing the fracture.

Treatment.—If any displacement should exist it must be corrected by pressure with the finger; then support the foot upon a pillow, and combat local inflammation.

If the fragments show any disposition to slip away from the natural position in which they have been placed, a splint with appropriate compresses may be applied to the sole of the foot and secured with a roller bandage.

Fracture of the Phalanges of the Toes.—The phalanges are broken by heavy bodies falling upon them, and the injury is such as

often to demand the removal of the toes with the knife. In fracture of the phalanges of the great toe the irritation is such at times as to cause inflammation along the course of the lymphatics to the groin. If a splint is deemed necessary, one covering the whole sole of the foot, made of wood, binder's board, or gutta percha, may be employed, to which the toes can be bound by a narrow roller.

Fig. 448.

Apparatus for ruptured tendo-Achillis.

RUPTURE OF THE TENDO-ACHILLIS.—This injury results always from muscular action occurring while persons are in the act of jumping.

The patient feels a crack about the ankle, and finds himself unable to extend the foot; with the fingers an interval may be felt between the separated ends of the tendon.

Treatment.—The treatment consists in bringing the ends of the tendon in apposition, and retaining them until union takes place between them. This is accomplished by position—the leg is flexed upon the thigh, and the foot extended upon the leg; the slipper of Monroe (Fig. 448) may be then applied in this manner: Put on the patient's foot an ordinary slipper having a strong cord attached to its heel; around the lower part of the thigh buckle a broad strap also, with a cord; now tie the two cords together, and the apparatus is completed (Fig. 448). The anterior ankle splint of Monroe and the apparatus of J. L. Petit are also excellent contrivances for maintaining the leg in the proper position.

PART IV.

DISLOCATIONS: THEIR REDUCTION, DRESSINGS, AND APPARATUS.

CHAPTER I.

SPRAINS OR STRAINS.

THE articulations are liable to be violently twisted, their joint surfaces separated, and the ligaments stretched, or even ruptured, without any permanent displacement of the bones entering into their composition; these injuries are popularly known as *sprains* or *strains*.

The symptoms are sudden and often severe pain, not unfrequently accompanied with a feeling of faintness; stiffness, and difficulty in executing the natural motions of the joint, about which there is more or less swelling and ecchymosis from extravasation of the blood into the cellular tissue, tendinous sheaths, and bursæ. This swelling, however, may occur some distance from the joint, over the junction of the muscular with the tendinous fibres, where laceration most frequently takes place when the muscles are forcibly stretched.

Effusion of serum into the textures near the injured part, and an increased secretion of synovia into the cavity of the joint, may alter its contour in such a manner that, without a very careful examination, the injury may be mistaken for a dislocation.

The chief discriminating feature of a sprain is the absence of any displacement of the bony surfaces entering into the formation of the joint.

Should the injury be very severe, to the foregoing local symptoms, especially when one of the larger joints, as the knee, is involved, great constitutional disturbance will be added; which, together with acute local inflammation, may produce dangerous, if not fatal consequences. All the joints are liable to sprains, but not in an equal degree; the ankle, wrist, and elbow being most frequently affected; the knee and hip less so; while they are rarely ever met with in the shoulder. The vertebral articulations, though so strong and so amply protected with large muscles, also suffer from sprains.

It is the ginglymoid class of joints particularly which is most obnoxious to these injuries; and a comparison of their anatomical construction with that of the enarthrodial joints will readily explain why this is so. In the first place, the hinge-like articulations move but in two directions, forwards and backwards; in the second, they are bound together

by short, strong, and thick ligaments, that yield very little to an extraneous force tending to separate the joint surfaces, and hence they are often torn; a circumstance enabling us also to account for the greater seriousness of these sprains than those of the enarthrodial or ball-and-socket joints, which have a greater range of motion, thinner, weaker, and more extensible ligaments—conditions that concur in conferring upon them a greater immunity from sprains and the laceration of the ligaments.

Of all the joints, the ankle suffers most often from this sort of violence, and the right ankle more frequently than the left in the proportion of three to one.

The injuring force acting upon the ankle will, in a majority of cases (twelve to one), cant the foot inwards, and produce what Dupuytren called an *external* sprain. The cause of this difference is stated to be the obliquity of the superior surface of the astragalus, which is from above downwards, and from within outwards; favored also by the circumstance that abduction of the foot is more easy and extended than adduction.

The spraining of the ankle by the movements of forced flexion or extension is more rare than by the lateral or twisting motions. Sometimes portions of the bone are detached with the tendons and ligaments, and add much to the seriousness and severity of a sprain.

Often, perhaps, many serious diseases of the synovial membranes and cartilages may be traced to a violent or a badly-treated sprain; and this will not cause surprise when the extent of some of these injuries is considered; the tendons, ligaments, cellular tissue, blood-vessels, nerves, muscles, and even the bone itself, participating to a greater or less extent in the mischief, according to the severity of the sprain and the state of the patient's constitution at the time of the injury.

It not unfrequently happens that even when the more serious symptoms have passed away, the swelling diminished, and some mobility restored to the joint, it still remains stiff and weak, and more than ever liable to sprains. When the knee is sprained by a fall or misstep, the violence is usually expended upon its internal lateral ligament, while the swelling will be found upon its external face.

It occasionally happens that the fascia forming the sheaths of muscles and tendons is ruptured, and permits them to spring outwards through the aperture. This form of accident is especially observed in the quadriceps extensor of the thigh, the long head of the biceps, and in the extensor tendons of the fingers.

Causes.—The causes of sprains are muscular contractions, falls, and violent or exaggerated motions of the joints, producing forced extension, flexion, lateral movements, or rotation.

Prognosis.—Where these injuries are slight, patients readily recover from them; although, even in these instances, in rheumatic subjects, persistent and serious symptoms often result.

Severe sprains may produce paralysis, atrophy, muscular rigidity, and chronic arthritis, the latter sometimes demanding amputation.

The greatest diligence should be exercised in making out a clear

diagnosis, before any plan of treatment is instituted. The manual examination must be thorough and at the same time gentle, that no unnecessary pain may be inflicted upon the patient.

Sprains have been very frequently confounded with dislocations; but proper attention to the diagnostic symptoms will generally prevent any such occurrence. It will be well to mention in this connection, that the hip-joint may be severely sprained by the slipping of the foot outwards, causing forced abduction of the limb and stretching of the capsular ligament, which may lead the practitioner astray in supposing a dislocation downwards and forwards into the thyroid foramen, from the somewhat analogous character of the symptoms of the two injuries.

Treatment.—In robust and plethoric patients, in whom the local inflammation and constitutional reaction are great, a moderate general bleeding may become necessary, but in most cases cupping or leeching will suffice.

Cold may be applied to the joint by the India-rubber sack already spoken of, which will enable the surgeon to obtain a uniform temperature of any degree.

A still simpler plan is to immerse the injured part in a vessel of water of the desired temperature. For instance, if it is the ankle, the pail containing the water must be placed by the patient's bedside, near enough to permit his heel to rest upon its bottom, a large sponge being interposed to prevent hurtful pressure; the thigh may be supported by pillows.

Irrigation by means of the apparatus described at pages 87 and 91 is also a good plan for obtaining the sedative influence of cold.

In slight cases of sprains, an immersion of the part in cool water for forty-eight hours will often relieve the pain and swelling sufficiently to enable the patient to dispense with it; in severer cases, to obtain any decided result an immersion of eight or ten days, or even longer, will be necessary.

Cloths wrung out of cold water, or water mixed with alcohol and tincture of camphor, wrapped about the joints, have been recommended as a convenient method; but the proper management of such a dressing is really difficult, for without the most assiduous attention on the part of the attendant inequalities of the temperature of the parts are sure to result in changing the cloths, and therefore frequent and injurious reactions must occur.

Cold affusion, by directing a stream of water from a pitcher held five or six feet above the bed upon the joint, in the first or acute stage of a strain, will be likely to do more harm than good by the frequent reactions thereby produced; but when the inflammatory symptoms have been controlled by appropriate remedies, cold affusion will contribute greatly to bring about a rapid convalescence.

Should cold be found disagreeable to the patient's feelings, fomentations with solutions of acetate of lead and opium, hydrochlorate of ammonia and opium, or warm salt water, may be substituted for it.

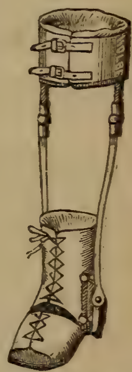
Poultices of scraped Irish potatoes, carrots, or hashed persil made with lead water, are the favorite remedies of some practitioners.

While the acute symptoms are passing away, the parts become discolored and pass through various shades of green, blue, purple, and yellow to the normal color of the skin. Any remaining stiffness, weakness, or swelling of the joints must be treated with stimulating applications, such as volatile liniment, Granville's lotion, and fish brine. Frictions and massage will likewise contribute to their removal.

Paralysis of a limb resulting from a sprain will be benefited by electricity, galvanism, the counter-irritation of the heated hammer adverted to farther on, and repeated blistering.

For some time after the injury it will be advisable to support the joint by elastic bandages. I sometimes find advantage accruing as regards comfort and facility in walking from the use of the apparatus seen in Fig. 449. It consists of an ordinary laced boot with two side stems attached to its sole and running up the limb to a point just below the knee, where they are connected together by a padded metallic strip which embraces this part of the leg; a spiral spring extends between one of the side rods and the sole of the boot, which by its elasticity brings the foot in a rectangular position again after it has been extended or flexed.

Fig. 449.



Shoe to assist in walking after dislocation.

It cannot be too forcibly impressed upon the mind of the student that all interference with the knife, with a view of giving issue to the effused blood, is highly reprehensible; as such incisions cannot accomplish this object; while, on the other hand, they would be likely to cause inflammation of the cellular tissue. Nature amply provides for the removal of the blood in due time by means of the absorbents everywhere present; while, it may be remarked, its temporary presence in the tissues will not be productive of any harm.

Compression, after the acute symptoms have passed, by means of a proper bandage, will exercise a beneficial influence upon sprained joints. Baudens has recommended one for the ankle which is exceedingly efficient and elegant. It is applied in the following manner: first pad the depressions below the malleoli with cotton or tow, and over this lay three compresses, imbricating and crossing them over the instep; then with a roller eight yards long and two inches wide inclose the ankle, beginning by placing its initial extremity upon the inner surface of the os calcis of the left foot (outer side for the right), as low down upon the point of the heel as possible, carry the cylinder obliquely across the dorsum of the foot to the root of the little toe, around the base of the toes to gain the inner border of the foot, then crossing the previous turn upon its dorsum go around the heel to the point of departure; continue these turns in this manner until the foot and ankle are neatly covered in. The bandage being completed, apply over its surface, with a brush, a solution of starch; in twenty-four hours it will be thoroughly dry. The limb should be kept quiet and in an elevated position from ten to thirty days according to the severity of the injury. For the knee, the middle part of the spiral bandage

described at page 209 will, when starched in the same way, serve a good purpose in keeping the joint immovable, and making compression.

Some constitutional treatment will be necessary in those persons who are of a gouty or rheumatic diathesis, or whose general health is shattered by long confinement; the appropriate remedies are colchicum, iron, cod-liver oil, and alteratives.

Although a slight sprain will get well under the use of tincture of arnica, spirits of camphor, or a mixture of laudanum and lead-water applied locally, while the patient is pursuing his ordinary occupation, yet it will always be the safest and surest plan to enjoin absolute rest for the injured limb a few days.

With the starched bandage patients can take exercise upon a crutch, which will contribute greatly in maintaining their general health until the parts are sufficiently recovered to submit to passive exercise, and thus gradually resume their natural functions.

This passive exercise should not be delayed too long; otherwise the joint may become irreparably damaged by anchylosis.

CHAPTER II.

DISLOCATIONS IN GENERAL.

Nomenclature.—A dislocation or luxation is the permanent displacement of joint-surfaces from their normal relations with each other.

When it results from external violence or muscular action, it is called a *traumatic dislocation.*

If the displacement occurs from some morbid changes in the joint itself, as ulceration or caries of its articular surfaces, it is termed a *pathological dislocation;* but, even in this case, muscular contraction or some slight external force is generally the immediate cause.

Congenital dislocation is such as is met with in recently-born infants, having occurred during intra-uterine life.

A *complete dislocation* is one where the joint surfaces have been completely separated from each other, and an *incomplete,* or *partial* dislocation, where they yet remain in apposition to some extent; the latter variety occurring mostly in ginglymoid articulations.

A single dislocation, as its name implies, affects but one joint, while in a *double dislocation* two corresponding joints upon opposite sides of the body suffer.

In *multiple dislocation* two or more luxations occur, not thus corresponding; for instance, those of the ankle and wrist, shoulder and hip.

The terms *recent* and *old* dislocations, although arbitrary, and of little value as mere expressions of lapse of time since the injury, yet they are of much practical importance when considered as indications

of the pathological changes that always follow it, and upon the nature and extent of which the ease or difficulty of reduction depends.

In a *primitive dislocation* the head of the displaced bone remains in the original situation in which it was first forced; in *consecutive dislocation* it abandons this position and seeks another, either in consequence of some peculiarity in the application of the violence, or from some diseased changes in the bones themselves.

No dislocation can occur without some injury to the surrounding soft parts; when this is moderate, or about the average amount, the luxation is technically said to be *simple*, while the term *complicated* indicates that it is accompanied with an unusual amount of contusion of the surrounding tissues, tearing of ligamentous and muscular fibres, rupture of some bloodvessel or nerve, or with a wound.

A *compound dislocation* is defined to be one where there is a communication established between the cavity of the joint and the external air.

Malgaigne proposes the adoption of the term *complex* to imply that the luxation is accompanied with articular fracture.

From the fact that all authors have not agreed as to which of the two bones comprising a joint should be considered as the displaced one, more or less confusion has arisen in consequence in designating the varieties of dislocation; and it was not until recently that the rule has been generally adopted to regard, in dislocations of the extremities, that bone displaced which is farther from the trunk; and in dislocations of the bones of the trunk, that one farthest from the cranium. The ankle-joint is, however, excepted from the rule without reason. The arbitrary use of such terms as downwards, upwards, forwards, backwards, and their combinations to express the direction of a dislocated bone, has also caused more or less perplexity; and, therefore, recent writers have abandoned them, and sought others more exact; so that now appellations, based upon the anatomical relations assumed by the head of the luxated bone, are coming into general use; for instance, instead of following Sir A. Cooper, and designating the four principal dislocations of the hip-joint as taking place upwards, backwards, forwards, and downwards, surgeons prefer to imitate Malgaigne and Nélaton, and adopt the anatomical terms iliac, ischiatic, ileo-pubic, and ischio-pubic to express them; the latter is certainly the preferable method.

FREQUENCY.—All the joints are liable to dislocation, but not in the same degree; the enarthrodial articulations suffer more frequently than the arthrodial, ginglymoid, and the amphi-arthrodial, under which latter fall the hinge-like joints, and those characterized by gliding movements of the bones upon one another, as is observed in the carpus, tarsus, and the junctions between the vertebræ. The greater range of motion of the enarthrodial or ball-and-socket joints, coupled with the anatomical arrangement of their constituents—a shallow socket, limited contact between their opposing bony surfaces, and loose capsular ligament—is the principal cause of this relative greater frequency. For, under these conditions, there is a much greater chance of a dislocation upon the application of external force than where the joint surfaces are

broad, and bound together by strong and thick bands of ligamentous fibres which limit the extent of joint motion to the simple gliding of the bones upon each other, or to that yet more extended movement forwards and backwards of which the knee is the most perfect type.

Besides these circumstances, the position of the bones will also have an important influence; as those most exposed will, *cæteris paribus*, be more liable to dislocation than the bones deeply seated or well protected with soft parts.

The operation of these influences is strikingly seen by reference to the following table of 488 cases, drawn up by Malgaigne:—

Dislocation of the shoulder	321	Dislocation of the fingers	7
" " hip	34	" " jaw	7
" " clavicle	33	" " knee	7
" " elbow	26	" " patella	2
" " foot	20	" " spine	1
" " thumb	17		
" " wrist	13	Total	488

The comparative frequency of dislocation in the upper and lower extremities is in the ratio of seven to one. The facility with which the epiphyses separate from the shafts of long bones in youth, and the brittleness of the bones in the aged, render these two classes of persons more liable to fracture than to dislocation, which last is most frequently encountered among persons between thirty and sixty-five years of age.

CAUSES.—The causes of dislocation are predisposing and exciting; among the former may be ranked age, sex, the state of the general health, and the position of the joint surfaces at the time of the infliction of the injury.

As has already been stated, it is rare in childhood and old age, on account of the condition of the bones at these periods favoring fracture rather than dislocation.

According to the interesting statistics of Malgaigne, males are more frequently affected than females in the proportion of seven to one; this is probably owing, in a great measure, to the less exposure of females to mechanical violence in their daily avocations of life.

Persons of relaxed habit of body, in general bad health, and who have suffered from rheumatism, gout, and syphilis, are liable to have their joints dislocated by a force which, were they in health, would not produce any permanent displacement.

Great relaxation of the ligaments, or a large collection of synovia in a joint, may permit a complete dislocation without any rupture of the tissues in its neighborhood, or will even enable the person to effect it at his pleasure.

Dr. Haynes, of Saratoga, New York, has reported a case of the kind in which a lad aged seven years was able to dislocate and reduce at will the knee, elbow, wrist, thumb, and fingers.

Sir A. Cooper relates three other instances: one of a dancing-girl who could throw the patella upon the outer condyle of the femur, and in whom this had occurred when a child from violent exertion; the second case was that of a lad who had been punished on board ship

by having his arm elevated and tied above his head while he stood upon a small projection upon the deck; he could dislocate the shoulder by merely elevating the arm to the head; the last case occurred in a man fifty years old, who had had his hip dislocated, and was ever after that able to cause it to happen whenever he chose.

The position of the articulating surfaces at the time of the application of the force will also have an important influence, inasmuch as in certain postures of the limbs the articular surfaces will not be in such close and extended contact as in others; as, for instance, when the arm is abducted and elevated, the thigh flexed upon the body, the lower jaw depressed; or lastly, when a limb is in a restrained or twisted position. All of these circumstances will materially favor the production of a dislocation.

The exciting or efficient causes are external violence and muscular action. The former acts either directly upon the joint, or indirectly upon it through the limb below, the latter mode being the most frequent in causing dislocation. We see the influence of indirect violence exemplified in these cases of luxation of the hip and shoulder produced by falls from a height upon the feet and hands. If, instead of alighting upon the feet and hands, the knees and elbows come first in contact with the ground, the force acts in a much more efficient manner, for the reason that the thigh and arm, being inflexible levers, transmit it undecompounded and undiminished to the joint above. The bending of a limb at an intervening articulation during the application of violence, will often prevent the occurrence of a dislocation.

Mere muscular action will sometimes effect a dislocation without the aid of external violence, and is due, in a great measure, to some accidental position assumed by a limb, destroying for the time the antagonism of the muscles inserted into the bone, one set of which thus acting more energetically than the opposing set, will drag the head of the bone from its socket into an abnormal position. Dislocation from muscular action has been observed most frequently in the temporo-maxillary and scapulo-humeral articulations, though cases are recorded in which the hip and patella have been luxated from the same cause.

Organic disease of the cartilages and ligaments from ulceration and caries will favor the occurrence of dislocation from muscular action.

Pathological Anatomy.—The pathological changes consecutive on dislocation are exceedingly interesting and important, and ought to be carefully studied by every person liable to be called upon to reduce a luxation, as it is upon the extent of these that the practicability of restoring the displaced bone depends after the lapse of some time. When a recent luxation is examined, the head of the bone will be found removed from its socket to a greater or less distance, according to the nature and degree of the violence that caused the displacement, and the character of the tissues surrounding the joint.

The ligaments will be ruptured in various degrees, from a mere slit just large enough to permit the head of the bone to escape from its capsule, to a complete laceration and separation, so that the shreds and remnants hang from the margins of the joint, or in front of its

socket, in such a manner as to interpose themselves between it and the head of the bone; the cartilages may be fissured, or even torn from the bone; and in complicated cases the nerves and bloodvessels sometimes participate, and are violently stretched or even lacerated, producing in the first instance paralysis of the limb below the dislocated joint, and in the other, hemorrhage into the socket and surrounding tissues.

The muscles about the injured articulation are usually more or less violently extended, contused, and the fibres sometimes torn through; generally tensely stretched upon one side of the joint, and relaxed upon the other.

Bones are, in general, more disposed to be luxated in certain directions than in others, according to the anatomical arrangement of the joints; thus the bones of the forearm at the elbow are more commonly displaced backwards, next laterally, and rarely forwards from the opposition offered by the olecranon hooking around the humeral condyles.

According to Malgaigne, the direction of the displacement is determined by the point and extent of the tearing of the capsular ligament.

When the bones are promptly restored to their natural relation at the joint, the functions of the limb will be again established, and the injury to the soft tissues repaired more or less perfectly, according to the amount and nature of the injury.

If this restoration is not accomplished within a few weeks, the inflammation which has begun in the parts will be attended with the effusion of plastic lymph about the joint, which will mat and glue the adjacent tissues into one mass; and in the progress of the case the cellular tissue becomes dense and thick, the neighboring muscles undergo fatty degeneration; the head of the bone, reposing upon some muscle, tendon, or bone, contracts new and intimate relations with them by the formation of a new socket and capsular ligament, communicating or not with the old capsule, according as its rupture was originally complete or not. An imperfectly organized synovial membrane will also be formed upon the inner surface of the new joint. The old socket participates in these changes, and is gradually effaced by its margins being levelled with the adjoining surface.

SYMPTOMS.—The symptoms of dislocation are, pain, alteration in the figure of the joint, deviation of the axis of the limb from a right line, and an alteration in its length; contusion and ecchymosis, immobility and absence of crepitus.

At the moment of the infliction of the injury the patient may be conscious of something having given way or altered its position in a joint, described by some as a "crack" or "noise;" pain is felt in the part, which varies in its intensity and character, but is generally severe (nervous and irritable persons suffering the most), and lasts for a few days or even weeks. It is caused by the stretching and rupture of the nervous filaments about the joint, and is aggravated by handling the limb, and also when inflammatory action supervenes. Should the principal nerve be pressed upon by the displaced bone, the extremity will tingle and feel numb.

The alteration in the normal contour of the joints is an important character in the symptomatology of dislocation. It is due to two causes: first, to the changed position of the extremities of the bones entering into their composition; second, to effusion of blood from the ruptured vessels, and inflammatory exudations.

From these two causes will proceed those alterations in the normal positions and relations of the bony prominences and depressions which are naturally present and recognizable about the joints in their healthy state.

If the swelling results from effused blood, it will occur immediately after the injury, while that from inflammatory action will appear, *pari passu*, with the increase of the inflammation.

An alteration in the axis of the limb will be observed, which, instead of representing a straight line, will be broken into two sections, placed at a greater or less angle with each other, according to the inclination of the displaced bone with that bone to which it is normally connected.

The limb will also generally be found more or less forcibly rotated inwards or outwards, and sometimes stands off from the body at an angle.

A dislocated limb will commonly undergo some change in its length; though in the ginglymoid joints, where from the breadth of the articular surfaces a partial displacement only most always occurs, no change of length will be observed. In most of the other joints some shortening takes place; yet there are some exceptions, the most notable of which are dislocation of the humerus downwards, and of the femur into the thyroid foramen; in both of these cases the limb will be lengthened half an inch or more.

Contusions and ecchymoses about the injured joint or elsewhere should not be forgotten or overlooked when considering the nature of this injury, and particularly the *modus operandi* of the force producing it.

Immobility is one of the most valuable symptoms of dislocations from the fact that the joints have an important agency in the functions of the limbs, so that any displacement of their constituent elements will bring about a speedy abolition of motion. This is seen in dislocation of the shoulder and hip where the patient cannot voluntarily move the affected arm or walk upon the leg without excruciating pain. These restrained motions will also be manifest when the surgeon manipulates with the limb, which always causes acute pain.

When the ligaments are thoroughly lacerated, there may be in the beginning, before the muscles are spasmodically contracted, preternatural motion, so that a fracture might be suspected where it really does not exist.

Immobility is due to several causes; the principal of which are muscular contraction, interlocking of the head of the displaced bone, as sometimes happens in dislocation of the elbow, the presence of some osseous prominence as seen in the hip, in which the projecting lip of the acetabulum will frequently oppose itself to any movement of the head of the femur, and lastly, ligamentous bands will cause it. It will

generally be found, however, that two or more of these causes will be in operation in the same case at the same time.

Crepitus is another symptom sometimes connected with dislocation, and results probably from the rubbing together of surfaces roughened by effused lymph. It is never observed until after the inflammatory process has been established; which fact gives strong support to the above explanation. Malgaigne attributes the crepitus to the rubbing of the head of the displaced bone against a bony surface denuded of its periosteum. However, the subdued dull sound produced by the rubbing together of roughened cartilages or synovial membranes is quite distinct from the sharp, quick, and dry sound proceeding from the friction of the extremities of a broken bone; and which, although not present in all cases of fracture, will yet be observed, when it is present, from the first moment of the injury. Lastly, if the surgeon seizes the dislocated joint in both his hands, when there is no great swelling, and directs an assistant to move the limb cautiously, he can generally recognize the head of the bone in its new position.

Diagnosis.—It should always be borne in mind that although in general a dislocation may be accurately diagnosed from those injuries and diseases which resemble it in their symptoms, yet there have been cases that have defied the skill of the most accomplished surgeons.

In their early stages, dislocations may be confounded with fractures near the joints, sprains and contusions; and in their later, or when the bone has remained unreduced for a long period, they have been simulated by anchylosis, white swelling, deformed callus, and exostosis. By a close attention to the symptoms we have already laid down, a dislocation, when seen early, may always be recognized. If the joint is much swollen and the bony prominences cannot be felt, accurate measurements of the limb should be made with a tape-measure, and comparisons made with the healthy limb. A knowledge of the manner in which the injury was produced may also throw some light on the diagnosis. The limb should be manipulated to ascertain the nature and extent of the movements possessed by it. M. Malgaigne recommends the use of a slim needle, which should be thrust through the tissues down to the bony surfaces, to ascertain with precision the relations of the prominences and depressions of the latter.

Prognosis.—In simple dislocation, when the head of the bone is promptly returned to its socket, and no great injury has been inflicted upon the limb, the joint is usually speedily restored to its normal integrity in between three and five weeks; so that the patient can use the limb without pain or inconvenience, although some disposition to subsequent displacement may yet remain.

Compound and complicated dislocations are more serious, both as regards danger to life and the ultimate usefulness of the limb. They usually result from a greater amount of violence than simple dislocation, and are hence dangerous in proportion to its amount, to the extent of the injury, and the importance of the parts damaged.

The joints are more frequently left in a weakened and altered condition, disposing them both to a recurrence of the dislocation and to subsequent inflammatory and ulcerative changes, which sometimes require amputation ultimately, to save the patient's life.

Treatment.—The treatment of dislocations presents four indications: 1st, to restore the bone to its normal position; 2d, to facilitate the restoration of the damaged parts; 3d, to re-establish the natural motions of the articulations; 4th, to combat any complications that may occur.

1. *To restore the bone to its normal position.*—There are two methods by which this may be accomplished: first, by manipulations; and second, by making extension and counter-extension.

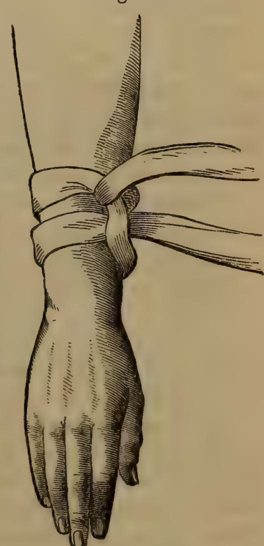
The first plan, or that by manipulation, consists in changing the position of the displaced bone in such a manner, by the hands of the surgeon, that those muscles which oppose the reduction are relaxed, while its head is thrown, by making a lever of the bone, near the socket, when the contraction of the muscles themselves will draw it with a "snap" into its natural position, and the reduction is accomplished. The details of the process, as applicable to individual dislocations, will be discussed under appropriate headings. Simple pressure with the fingers will often succeed in replacing the bones when only partially luxated.

The second process, or that by extension and counter-extension, is effected by the natural forces of the surgeon, aided by assistants if additional power is requisite, or by the application of certain mechanical appliances. The extension should be gradually made, with the least possible pain and inconvenience to the patient; the part to which the extending lac is applied must be protected by being covered with a wet roller, to protect the skin and prevent its slipping. In putting on this roller, the integuments may be drawn up a little, so that the traction will not stretch the skin painfully before the extending force is brought to bear upon the parts beneath.

Fig. 450.

The clove-hitch.

Fig. 451.



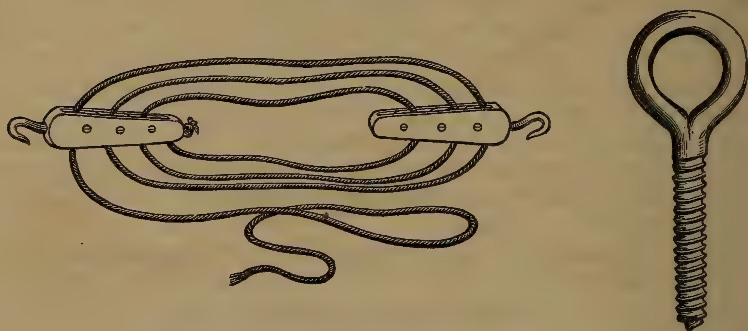
Application of the clove-hitch.

A secure way of fastening the extending lac over the wet roller is with the clove-hitch; its two ends are then knotted so as to form a loop, which affords the surgeon a good purchase if he wishes to use his hands; or it may be placed over the hooks of the pulleys.

Any amount of power can be obtained with the pulleys (Fig. 452); but they are not now

much employed since the introduction of the anæsthetics, which so thoroughly relax the muscles that with the hands alone almost all recent cases of dislocation may be promptly reduced. If it is necessary, however, to have recourse to them, the patient should be placed in a recumbent posture, or permitted to sit up, as found most convenient, and the extending lac applied as we have above described; or a broad leather belt with a loop attached may be buckled around the limb, to which one of the hooks of the pulleys is fastened, the other hook

Fig. 452.



Pulleys and iron ring to which one of their hooks is fastened.

being placed in the iron ring screwed into the wall. The counter-extending band, formed of a sheet or a broad piece of strong muslin, is arranged in an opposite direction to the pulleys, and its two ends secured to a point in the wall or floor in the line of the direction of

Fig. 453.

Application of the pulleys.

traction. Fig. 237 illustrates the mode of reducing dislocation of the hip by the pulleys.

Dr. Fanestock, of Pittsburg, Pa., instead of the pulleys has recommended as a good substitute the rope windlass, which is thus described by Dr. Gilbert: "Place the patient, and adjust the extending and counter-extending bands as for the pulleys; then procure an ordinary bed-cord, or a wash-line, tie the ends together and again double it upon itself, pass it through the extending tapes or towels, doubling

the whole once more, and fasten the distal end, consisting of four loops of a rope, to a window-sill, door-sill, or staple, so that the cords are drawn moderately tight; finally, pass a stick through the centre of the double rope, then, by revolving the stick as an axis, or double lever,

Fig. 454.

Application of the rope windlass.

the power is produced precisely as it should be in such cases, viz., slowly, steadily, and continuously."

The same steady and continuous power may also be obtained by another simple contrivance, the dislocation tourniquet of Mr. Bloxham, of London. This instrument resembles the ordinary tourniquet of Petit, and acts in a similar manner; by turning the screw the extending cord, which is fixed between the band encircling the limb and a staple in the wall, is gradually shortened by almost imperceptible increments of power until the bone is drawn into its natural position.

Mayor, Sédillot, and other European surgeons have devised special instruments for the purpose of making extension; but those already described will answer every purpose as well as the most complex machines.

Fig. 455.

Bloxham's dislocation tourniquet.

The surgical adjuster of Dr. Jarvis is also a powerful instrument, and has been employed by its inventor successfully in many cases of old luxations.

Another mode of applying power to a dislocated limb is by continuous elastic extension, which is certainly destined in future to play an important role in the treatment of this class of injuries, especially in "old" and congenital luxations. As my experience in its use has been limited to two cases of old dislocation, I am at present illy prepared to decide upon its merits from personal observation, yet a consideration of its mode of action, and a knowledge of its effects in other surgical injuries, in which the contraction of the muscles plays an important agency, induce me unhesitatingly to accept the present success of elastic extension in the reduction of old and congenital dislocations as a harbinger of more brilliant triumphs in this field of surgical therapeutics.

Much credit is due to Dr. Henry G. Davis, of New York, for the development of this important principle. He remarks, "that by this plan of elongating the soft tissues, all dislocations, whether recent or of *many years*' standing; all fractures, all deformities that are dependent upon the soft tissues are entirely within our control. These soft tissues can be *elongated* or *shortened* as we please. Ligaments that are inextensible, that are designedly made unyielding, are no exception to this rule. . . . . We have reduced dislocated hips at all periods of time, from the recent up to that of fourteen years' standing, and, in the latter case, restored a club-foot on the same limb at the same time.

"So far as the certainty of a reduction is affected, a luxation of twenty years' standing is upon the same footing as one of twenty days. The principal difference is in the length of time required to accomplish it. We do not say there is the same certainty of the joints being equally useful in both cases, only that each can with certainty be restored to its original locality.

"All danger of injury to the bloodvessels or nerves by this mode of preparing the parts will be avoided, as they elongate with the other soft tissues. This is of the highest importance; for it is well known that in old dislocations of the humerus attempts at reduction have in some instances been most disastrous."

The mode of applying the elastic cords will, of course, vary with the position of injured joints; the general plan being to apply adhesive strips to the limb below, to which the elastic cords may be attached, the balance of the arrangement will readily suggest itself to the surgeon as the requirements of the various cases are presented to his mind.

2. *For fulfilling the second indication, that is, to facilitate the restoration of the damaged tissues.*—The joint should be kept quiet, and in such a position that the dislocation is not likely to recur; during the time that the torn ligaments are healing a suitable amount of support must be given to the joint.

3. *The third indication, to re-establish the natural motions of the articulation,* demands that, as soon as the inflammatory symptoms have abated, passive motion must be had recourse to, and persevered in

daily until the functions of the joint are restored; which will seldom occur inside of several months.

Absorption of the effused fluids will be materially hastened by infrictions of volatile or other stimulating liniments, the cold douche, friction, and the massage.

4. *The fourth indication, to combat any complications that may occur,* requires the employment of antiphlogistics, general and local, to control the inflammation, which is developed in the joint in almost all cases.

The best local applications are evaporating lotions of alcohol and water, and solution of acetate of lead, with the tincture of opium.

If the case should be complicated, with the laceration of a nerve, or an artery (in the latter instance giving rise to aneurism) the bone should be reduced in the usual manner, and the injured nerve and aneurism subsequently treated as though they were primary affections.

CHAPTER III.

PARTICULAR DISLOCATIONS.

SECTION I.

DISLOCATIONS OF THE HEAD AND TRUNK.

Dislocation of the Inferior Maxilla.—Dislocation of the inferior maxilla takes place in two modes: First, both condyles are displaced from the glenoid fossæ—*bilateral* or *double* dislocation; second, one condyle only is so displaced—*unilateral* or *single* dislocation.

Fig. 456.

Double dislocation of the lower jaw.

The former variety occurs most frequently in the proportion of three to one.

An outward displacement of one of the condyles has been observed; but this can only happen when accompanied with a fracture upon the opposite side. Dislocation of the lower jaw is always complete; those cases described as subluxations appear to be nothing more than the catching of the head of the coronoid process against the anterior border of the inter-articular cartilage.

Causes.—It arises from two sources, viz., muscular action and external force, the former being much more frequent than the latter.

According to Malgaigne, of 40 cases of this injury 25 resulted from muscular action, viz., from gaping, 15; from convulsions, 5; from vomiting, 4; from rage, 1; and 15 from external causes, viz., from extracting teeth, 9; from thrusting large objects into the mouth forcibly, 6. Bérard saw a case of unilateral displacement resulting from force applied at the left angle of the jaw from behind forwards. He thinks it probable that the chin may have been depressed to some extent at the time of the reception of the injury. Cases are also reported where the dislocation resulted from excessive salivation and violent gesticulation.

In the majority of cases dislocation happens in adults between the ages of twenty and thirty years, though Malgaigne and Nélaton have observed it in an aged subject, and in one but five years of age.

This peculiar exemption in infancy and in old age is ascribed by Nélaton, who has made special researches into this subject, to the fact that at the former period of life the coronoid apophysis is too short, and in the latter too much inclined backwards for it to reach the position it always assumes in dislocation, that is, against the inferior angle of the malar bone outside of the tubercle formed by its junction with the superior maxillary.

In order to understand the mechanism of the dislocation, it will be well to remember that the temporo-maxillary articulation is provided with a capsular ligament divided into two cavities by an inter-articular cartilage, each lined by its own proper serous membrane; the external lateral ligament passes from the tubercle of the zygoma to the external surface of the neck of the lower jaw; the internal extends between the spinous process of the sphenoid bone to the margins of the dental foramen; and therefore has no connection with the joint. The masseter, temporalis, and internal pterygoid muscles draw the lower jaw upwards and forwards against the upper; the genio-glossus, genio-hyo-glossus, mylo-hyoid, and digastricus, depress the chin, while the external pterygoid and a few fibres of the masseter muscle bring it forwards. This anatomical arrangement will permit the condyles to slip forwards upon the transverse apophysis of the temporal bone when the mouth is widely opened, and to regain their position in the glenoid fossæ when it is shut. Now if when it is in the former position the chin be still further depressed by muscular action, the condyles will be displaced forwards by the combined efforts of the external pterygoid and a few of the fibres of the masseter. Instead of the muscular action, if a violent blow be inflicted upon the chin which forcibly depresses it, the necks of the condyles will be brought more in a parallel line with the direction in which the fibres of the internal pterygoid and the masseter act; then, instead of elevating the jaw by making a fulcrum of the condyles at the glenoid cavities, which always happens when the necks of the condyles are in an oblique position to these fibres, these muscles will draw the condyles into an abnormal position forwards.

The mechanism of unilateral dislocation is the same; the condyle which is not displaced will be rotated in the glenoid cavity, while the

opposite one will take its ordinary position.

Fig. 457.

Dislocation of inferior maxilla.

Symptoms.—The symptoms in recent cases of dislocation of the inferior maxilla are quite characteristic. (Fig. 457.) The chin is depressed and prominent, the mouth widely opened, the lower teeth project beyond the upper, so that the whole expression of the face is repulsive; the saliva drips from the mouth, and articulation and deglutition are impossible, or performed with difficulty and pain. The jaw is immovable and painful from the pressure upon the temporal nerves; the temples and cheeks are flattened and apparently elongated; there is a prominence over the condyles, and between them and the meatus a depression with the skin tensely stretched across it.

In rare cases the symptoms are not so prominent, and one is related in which the injury was not discovered, and the jaw remained permanently unreduced. In an instance of this kind, the jaws gradually approximate each other so that the patient can masticate his food, and articulate with little difficulty; the saliva will cease to escape from the mouth, while the face will assume a tolerable appearance, although the chin will ever remain a little advanced.

In unilateral luxation the chin will be generally found turned to the side opposite that on which the condyle is displaced; but one depression will be observed in front of the ear; the mouth will be less widely opened, and speech and deglutition interfered with in a less degree.

Prognosis.—In recent cases the reduction is always easy, and the jaw will be restored to the full enjoyment of its functions. More difficulty will be encountered in those of longer standing. Stromeyer reduced a dislocation of thirty-five days' standing, and Donava one of ninety days. To facilitate the operation in such instances it has been proposed to divide the masseter and internal pterygoid muscles subcutaneously.

Treatment.—The indications of treatment are, to reduce the dislocation and to prevent subsequent displacements, to which there is always a tendency for some time afterwards.

To accomplish the former object many plans have been suggested. The common one is to seat the patient upon the floor or a low stool; the surgeon, standing in front of him, places his two thumbs, previously wrapped with a bandage to protect them from being pinched between the teeth when the jaws come together, upon the molars, while the other fingers grasp the jaw, and presses downwards to disengage the condyles; then, with a sudden movement, he elevates the

chin, and the reduction is accomplished, generally with an audible *snap*.

Sir A. Cooper introduced between the molars little wooden wedges, or the handle of a knife or fork; and while an assistant held them in position, he placed himself behind the patient, and dragged the chin upwards by means of a sling placed beneath it.

Ravaton simply elevated the chin, making a fulcrum of the molar teeth.

J. L. Petit describes a method that was pursued by some surgeons, consisting in striking a strong blow with the fist upon the under surface of the chin, in some of the cases a piece of wood having been previously interposed between the jaws.

Nélaton recommends the thumbs to be introduced into the patient's mouth, and pressure be made upon the coronoid apophysis directly backwards, the other fingers taking a *point d'appui* upon the mastoid processes; this pressure may even be made externally beneath the malar bone.

Stromeyer used a specially constructed instrument, provided with forked branches fitting the dental arches above and below, and strong handles.

For fulfilling the second indication, that of preventing the dislocation recurring, a sling-bandage should be applied to the jaw to maintain it at rest for a week or ten days, then exercise it gently, that anchylosis may not take place; the patient should confine himself to fluid or pap-like food for several days.

Sir A. Cooper has described a condition which he designates as *subluxation of the jaw;* but from the experiments of Nélaton it would seem that the eminentia articularis does not offer any obstacle to the return of the condyle to the glenoid cavity, after the mouth has been widely opened, and hence there is nothing short of a complete dislocation. The condition alluded to occurs particularly in scrofulous and weakly people, whose tissues and ligaments are relaxed, and those about the temporo-maxillary articulation perhaps participating, may allow greater play to the inter-articular cartilage, enabling it to slip behind the condyle, and thus arrest the motion of the jaw suddenly. This happens while the patient is eating or speaking; the mouth remains half open, the chin slightly advanced forward; and he has a sensation as if the condyle had slipped from its place, and feels pain upon the injured side.

The malposition of the cartilage happens especially in delicate females, and is much benefited, and even cured, by tonic medication. The cartilage will easily slip into place by slight lateral movements of the jaw, or with the hand drawing the chin downwards and forwards.

Dislocation of the Vertebræ.—The vertebræ are so strongly bound together by ligaments, and their articular surfaces so broad, that they are rarely found dislocated; indeed, some surgeons have doubted the possibility of it unless associated with fracture. There are, however, on record well-authenticated cases occurring in the cervical region, where the vertebræ enjoy a much greater range of motion than in the other portions of the spine; yet even here, fracture

generally accompanies the dislocation. Luxation of the occipito-atloid articulation will be followed either by immediate death, or occurring within a very short period.

From the greater range of motion in the atlo-axoid articulation it will be found to suffer more frequently than the preceding joint from dislocation.

It is produced by falls from a height upon the head, violent blows upon the nape of the neck, and forced flexion of the head upon the chest. It has also been known to occur in children by raising them from the ground by the head.

The transverse ligament of the atlas is either ruptured, or the odontoid process slips beneath its lower border and is thrown against the spinal cord.

The five lower cervical vertebræ may be dislocated forwards or backwards, the dislocation being complete or incomplete according as the articulating processes are wholly or partially separated from each other. If these are equally advanced, the luxation is bilateral, and unilateral when only one process is thrown forward, while the other retains its connection. Complete dislocation usually terminates fatally in a day or two, while incomplete and unilateral dislocation may linger on some time longer, from four to six weeks.

The dorsal vertebræ are most commonly displaced posteriorly, the fifth, eleventh, and twelfth pieces being those most usually observed to suffer; and the dislocation is almost invariably associated with fracture of their bodies and processes.

Treatment.—The correct diagnosis of a dislocation of a vertebra is extremely difficult in most cases; and this fact, perhaps, has deterred most surgeons from any active interference in this class of injuries of the spine. In several instances, however, where the dislocation has been seated in the cervical vertebræ, it has been recognized and successfully reduced. Mr. Erichsen says he has seen unilateral dislocation of the cervical vertebræ reduced by the surgeon placing his knees against the patient's shoulders, drawing on the head, and then turning it into position, the return being effected with a distinct snap.

In Dr. Ayres' case of dislocation of the fifth cervical vertebra, counter-extension was made by placing two folded sheets obliquely across the shoulders properly secured, and extension by the hands of the surgeon, one being placed under the chin and the other over the occiput; the traction being made first in the direction in which the head was thrown, or directly backwards, and then upwards. The patient had been thoroughly anæsthetized before the manipulations were commenced, and the bones were distinctly felt to slip into their places.

Dr. Graves, of New Hampshire, reported a case of dislocation of the last dorsal vertebra successfully reduced by extension and counter-extension from the armpits and hips; the patient was placed upon his face, and chloroform administered until he was completely under its influence.

These cases will serve to illustrate the general method of procedure in dislocation of the vertebræ.

Dislocation of the Sternum.—This dislocation, which is very rare, occurs at the junction of the first with the second piece of the sternum. In early life these pieces are connected together by cartilage and two ligaments, anterior and posterior; in rare cases a true arthrodial joint is formed.

The form of displacement which has been observed in the ten recorded cases of this injury, consists in the lower extremity of the manubrium being depressed below the level of the body of the sternum.

Causes.—Direct violence upon the sternum, as from a heavy blow with a club, and falls from a height upon the head and nates or lower extremities. The mechanism of the dislocation from the two latter causes is explained in this manner. When a person falls upon the head the weight of the body forces the chin violently against the sternum and depresses the manubrium. The same result will follow if the person alights upon the nates; the neck will be violently flexed throwing the chin against the chest.

Symptoms.—The symptoms of this injury are—pain over the sternum, increased by pressure and the respiratory movements; when the finger is passed from the top of the sternum downwards it will encounter the projection formed by the upper extremity of its body.

Prognosis.—Dislocation of the sternum is always a serious injury, being accompanied in the majority of cases with dangerous lesions of the organs of the thoracic and cerebro-spinal cavities.

Treatment.—The efforts of the surgeon will generally be confined to combating the inflammatory complications as they arise; while if it should be deemed prudent to attempt the reduction in consequence of the pressure of the displaced bone upon the parts beneath, it may be accomplished by making strong pressure upon the dorsal region from behind forwards, counter-pressure being established at the same time over the chin and pubis.

When the reduction is effected place a compress on the seat of injury, and confine it with a body bandage, or a broad strip of adhesive plaster.

Dislocation of the Ribs and Costal Cartilages.—The ribs may be dislocated upon the vertebræ, upon the sternum, and upon each other. Saurel also speaks of chondro-costal dislocation: but as there are no true joints between the ribs and their cartilages a separation at this point should rather be regarded as a fracture.

From the nature of the connections of the ribs with the vertebræ by strong ligamentous bands, some surgeons have doubted the possibility of a dislocation, yet unquestionable instances of the kind are upon record, and particularly of the lower ribs. It is, perhaps, true, however, that in most cases there will be found associated with a dislocation fracture of the transverse process of the vertebra, or of the necks of the adjoining ribs.

The injury will in all cases be found to result from heavy blows upon the back; the displacement, which occurs in most cases is inwards.

Symptoms.—It will be exceedingly difficult to make out a clear diagnosis in these cases from their similarity to fracture of the necks of

the ribs. Chelius says "that dislocation of the rib may be distinguished by its greater mobility, when the finger is run along it, and which is still more perceptible the nearer it approaches the hinder end; by a particular rustling (which is not to be confused with that from fractured rib, or from emphysema), which is perceived on the movements of the body and ribs by the practitioner, or by the patient himself; by a yielding of the parts covering the hinder end of the rib; by a depression where the head of the rib should be found, and by motion of the hind end on pressure of the front end. It is accompanied with cough, difficult respiration, severe pain, and other symptoms, as in fractured ribs."

The reduction may be attempted by placing the patient upon his back upon a firm mattress, and making firm pressure upon the anterior extremity of the ribs so as to force its head backwards into its natural position. Compresses may then be laid over the front and back of the chest, and confined by a thoracic bandage.

The costal cartilages may be dislocated upon one another, particularly the seventh upon the eighth, the eighth upon the ninth, and the ninth upon the tenth, between which there are joint-surfaces incrusted with cartilage, lined with synovial membrane, and connected by ligaments.

The injury results from the violent bending backwards of the body, and presents the following symptoms: acute pain over the cartilage from any exertion, prominence of the overlapping piece, with a corresponding depression by its side over the piece beneath; some disturbance of the respiration, and a dull creaking sound may be heard when the chest walls move in forced breathing.

The reduction is easily effected by directing the patient to bend his body backward, and making pressure upon the displaced cartilage, over which a compress is now to be placed, and confined by a body bandage.

A chondro-sternal dislocation may take place by the cartilage being depressed beneath the sternum. It generally happens in children of weakly constitution, and will be recognized by a depression at the seat of injury; the reduction may be attempted by directing the patient to take deep inspirations. The after-treatment requires the thoracic walls to be kept at rest by a broad bandage.

SECTION II.

DISLOCATIONS OF THE UPPER RXTREMITIES.

DISLOCATION OF THE CLAVICLE.

I. INNER EXTREMITY.
   1. Forwards.
   2. Upwards.
   3. Backwards.

II. OUTER EXTREMITY.
   1. Upwards.
   2. Downwards.
   3. Downwards under coracoid process.

III. DISLOCATION OF BOTH EXTREMITIES.

I. Dislocation of the Inner Extremity of the Clavicle.—The inner extremity of the clavicle is held in connection with the sternum by a capsular ligament forming a joint, divided into two compartments by an inter-articular cartilage, in the same manner as seen in the temporo-maxillary articulation. This connection is still farther strengthened by a ligament passing between the two clavicles, and also one between the clavicle and first rib, which all together form an articulation of considerable strength; so that it is uncommon to find a dislocation at this point. When it does happen, the displacement may occur in either one of three directions; forwards, upwards, or backwards; the former being the most frequent.

1. *Dislocation forwards.*—It may be complete or incomplete; in the former case, the capsular ligament will be torn through; the inter-articular cartilage will sometimes be carried forwards with the end of the clavicle, and sometimes remain connected with the sternum; the costo-clavicular ligament will be much stretched, frayed, or even torn; in the latter the capsular ligament is only forcibly stretched.

Causes.—The most common cause of this variety of luxation is some sort of violence applied to the back part of the shoulder, which drives the clavicle obliquely forwards and inwards, as when a person falls upon the shoulder from a height. (Fig. 458). Other causes have also produced it; pressure of the shoulders together by being caught between a carriage wheel and a wall; falls upon the elbow when the arm is thrown forward; muscular exercise, in swinging the dumb-bells, or endeavoring to support a weight upon the head or shoulders. Boyer has seen a case in a young girl who suddenly threw her shoulders backwards to assume a more graceful attitude.

Fig. 458.

Dislocation of the sternal end of the clavicle forwards.

Symptoms.—At the time of the injury some pain will be felt at the top of the sternum, upon the front of which a hard tumor formed by the extremity of the clavicle will be seen, which changes its position when the shoulder is moved; the sterno-clavicular articulation presents a depression instead of its natural prominent outline. The shoulder is raised with difficulty, thrown backwards, and brought nearer the median line; in tracing the line of the clavicle with the fingers it will be found to be more oblique, running forwards and downwards and inwards from the shoulder; the clavicular portion of the tendon of the sterno-cleido-mastoid muscle is prominent and tense; the head of the patient inclines to the injured side.

Prognosis.—This luxation is not attended with danger, and though the surgeon may not be able to keep it reduced, little injury is inflicted thereby upon the functions of the limb.

Treatment.—The indications of treatment are, first, to reduce the luxation, and second, to maintain it thus until the lacerated ligaments shall have regained sufficient strength to prevent any further displacement.

For fulfilling the first indication, the patient is seated upon a chair, the surgeon standing behind him places his right knee between the scapulæ, and seizing the two shoulders in his hands he draws them back, which, with a little pressure upon the displaced extremity of the bone, will effect the reduction: or he may accomplish the same object by making a lever of the arm of the injured side; while the left hand supports the corresponding axilla, his right is used to grasp the elbow, and, carrying it backwards, he forces the clavicle into its natural position.

To answer the second indication, various apparatus have been proposed, yet it is very difficult, in many instances, to succeed with any of them. It is fortunate, therefore, that so little inconvenience results from an unreduced luxation.

A very simple plan is recommended by Nélaton, who employed an ordinary hernial truss, the anterior pad of which is intended to make pressure over the sterno-clavicular articulation, while the posterior one takes a *point d'appui* in the axilla of the sound side.

M. Mélier made use of the apparatus of Brasdor for fractured clavicle, to the dorsal plate of which he fastened a steel spring curving over the injured shoulder, and furnished at its end with a concave pad for making pressure upon the inner extremity of the clavicle.

Sir A. Cooper recommended an apparatus consisting of two padded rings for the shoulders buckling to two dorsal plates, which are to be drawn together by straps; to prevent the plates being displaced upwards, two straps also connect them with a belt encircling the body.

Whichever apparatus is employed, it will be necessary to keep it on the patient six or eight weeks, or even longer, in order to overcome the disposition to reluxation.

2. *Dislocation upwards.*—This is a rare accident, and appears to have resulted in a majority of the recorded cases from a force acting upon the shoulder, pressing it downwards.

When the luxation is complete, the ligaments are ruptured as in the preceding case.

Symptoms.—The inner extremity of the clavicle is found forming a tumor upon the top of the sternum; or, perhaps, as seen in one case, is driven across the median line beneath the sterno-cleido-mastoid muscle of the opposite side; the space between the clavicle and first rib is increased, and at its bottom the semilunar notch upon the side of the sternum may be felt; the shoulder is depressed and inclined to the front, and the tendon of the sterno-cleido-mastoid is shoved prominently forward. Should the end of the clavicle press against the trachea, as it has been seen to do, difficult respiration will be added to the rest of the symptoms.

Prognosis.—Considerable difficulty will be encountered in retaining the bone reduced; and sometimes it is found impossible; but in this

case even the patient will not suffer any material loss of power in the arm.

Treatment.—The reduction is easily accomplished by drawing the shoulder upwards and slightly backwards, at the same time making pressure upon the clavicle from above downwards. As a retentive bandage, Velpeau applied his apparatus for fractured clavicle, and kept it on fifty days without succeeding in keeping the luxation reduced. Malgaigne believes this impossible without some remaining deformity. A gutta-percha splint may be moulded to the clavicle and ribs, and sustained in position by a roller bandage passing around the elbow and over the shoulder, and terminated by a few turns encircling the chest and arm, to retain the latter at rest.

3. *Dislocation backwards.*—This kind of dislocation has been seen in thirteen or fourteen cases on record; the inner extremity of the clavicle takes its position beneath the sterno-hyoid muscle, and is inclined in some cases upwards, and in others downwards.

Causes.—In a majority of the recorded cases the injury has resulted from crushing violence applied to the upper part of the chest; in a few instances from the shoulders being violently pressed together between two objects; or from falls upon the shoulder forcing it from behind forwards.

Symptoms.—The symptoms are, difficulty in moving the shoulder and arm; the shoulder approaches nearer the median line, and if the inner end of the clavicle inclines downwards, it will be elevated; or it will be depressed if the inclination is in the opposite direction; in the former case the slope of this bone being inwards and downwards, and in the latter inwards and upwards. A depression will exist over the semilunar notch into which the finger may be thrust; and the patient's head inclines to the uninjured side. There is sometimes embarrassment of the respiration from pressure of the end of the clavicle upon the trachea.

Prognosis.—In those cases in which reduction has not been accomplished, the functions of the arm have not been impaired.

Treatment.—The replacement of the end of the clavicle in the semilunar notch may be effected by drawing the shoulder upwards, outwards, and slightly backwards, and the reduction should be maintained, if possible, by the posterior figure of 8 bandage, and a pad laid between the scapulæ. The same object may also be obtained by placing the patient upon his back with a small pillow between his shoulders.

II. Dislocation of the Outer Extremity of the Clavicle.—Dislocations of the outer extremity of the clavicle are much more common than those of the inner. Its articulation with the acromion process is less broad and less firmly bound together with strong ligaments than at the sternum, while the position of the joint at the tip of the shoulder is more exposed to the action of external forces. When detached from its natural connections with the scapula, the acromial end of the clavicle may be displaced upwards, downwards, or downwards beneath the coracoid process.

1. *Dislocation upwards.*—This is the most common variety of the

luxations of the acromial extremity of the clavicle; and is either complete or incomplete. In the former case, the ligaments surrounding the joint will be completely ruptured, and the point of the clavicle will either rest upon the edge of the upper surface of the acromion process, or project across it to the extent of half or three-quarters of an inch.

Fig. 459.

Dislocation of the outer end of the clavicle, upwards and outwards.

Causes.—The common cause producing this dislocation is a fall upon the point of the shoulder while the arm rests along side of the body. Malgaigne mentions a case produced by a fall upon the elbow, and Nélaton another from a heavy weight striking the clavicle from above.

Symptoms.—The symptoms are, pain at the seat of the injury; the shoulder is slightly depressed and somewhat nearer the median line, the patient has great difficulty in abducting the arm, which hangs by his side; and in most cases he cannot place the hand upon his head; the arm can, however, be moved freely backwards and forwards. The end of the clavicle will be found forming a hard tumor upon the top of the shoulder, terminating externally by a depression; in passing the finger along the spine of the scapula, acromion, and clavicle, the latter will be felt thrown out of the continuous line which they naturally form.

Diagnosis.—This injury has been mistaken for fracture of the clavicle and dislocation of the head of the humerus: but a careful comparison of the above symptoms and those of these two accidents will certainly prevent any blunder.

Treatment.—The reduction is accomplished by carrying the shoulder upwards and outwards, while at the same time pressure is made with the fingers upon the displaced bone. Here the difficulty begins; for despite the application of the most ingenious contrivances the bone will generally slip from its place again and again. Should the dislocation remain unreduced, little harm comes of it, as the patient can use his arm with as much freedom as though nothing had happened.

The apparatus of Bartlett for fractured clavicle has sometimes succeeded; an additional strap is employed, which passes over the injured shoulder, and forces the clavicle downwards; and thus counteracts the action of the clavicular insertion of the trapezius muscle.

The apparatus of Desault answers the same indication, inasmuch as the third roller encircles the shoulder and elbow.

M. Baraduc has suggested a somewhat similar bandage; he encircles the arm with the turns of a roller to prevent the other parts of the dressing slipping, and places it by the side of the chest; the first

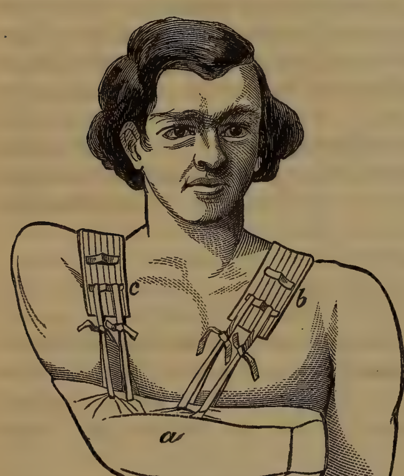
roller is applied circularly around the arm and chest, and compresses are placed upon the top of the shoulder, the luxation having been previously reduced; then a second roller is made to pass over the shoulder, and under the elbow until seven or eight turns are laid on, and these are prevented from slipping by circular turns around the chest and arm.

It has been attempted to make the necessary amount of pressure upon the clavicle with the ordinary tourniquet, the pad being placed upon the shoulder and the straps buckled beneath the corresponding elbow.

Malgaigne has devised an apparatus consisting of a strongly woven band about four inches wide, and long enough to reach around the shoulder and elbow; one of its ends is furnished with a buckle, and the other with a strap; between these an elliptical piece is cut from the band. To apply it, place compresses over the acromial end of the clavicle, and upon the elbow; slip the elbow into the elliptical hole of the band, which must now be buckled over the shoulder; to prevent the band slipping from the clavicle, a thoracic strap should be attached to it, passing around the uninjured side.

M. Mayor recommends the apparatus seen in Fig. 460. It consists of a sling for the forearm, and two broad belts passing over the shoulders, and attached to it in front.

Fig. 460.



Apparatus of Mayor for dislocation of the clavicle.

2. *Dislocation downwards.*—It is a rare form of luxation, and but three cases have been recorded. It results from blows upon the top of the shoulder, which displace the acromial end of the clavicle downwards beneath the acromion process, and between it and the capsular ligament of the head of the humerus, and is accompanied with a rupture of the acromio-clavicular, coraco-acromial, and coraco-clavicular ligaments.

Symptoms.—The clavicle slopes outwards; a depression will be felt over the acromio-clavicular articulation, and, further outwards, an eminence, formed by the projection of the acromion process and the inferior angle of the scapula, projects backwards. The arm can be moved freely forwards and backwards, but the motion of abduction will be much more restricted.

Treatment.—The reduction in this case is accomplished by drawing the shoulders outwards, the knee of the surgeon having been previously placed between the scapulæ.

There was no disposition to reluxation in the cases observed.

M. Tournel employed in his case at first the bandage of Desault for fracture of the clavicle, and afterwards that of Flamand; the cure was complete on the thirty-second day.

3. *Dislocation downwards under Coracoid Process.*—Dislocation downwards under the coracoid process is also a rare form of luxation, there being six cases on record. It is caused by falls upon the shoulder; and has in the larger number of instances been observed among persons advanced in age.

Symptoms.—The symptoms are depression and slight inclination forwards of the shoulder; when the finger is passed along the border of the acromion process forwards, the clavicular prominence is found wanting, while the coracoid and acromion project boldly forwards; the clavicle slopes outwards, and its distal extremity can be felt in the axilla. The inferior angle of the scapula is pushed outwards and backwards.

Treatment.—To replace the luxated bone bring the elbow of the injured arm to the side of the chest, and while the surgeon supports it here in his left hand he puts his right hand in the axilla, and draws the upper extremity of the humerus outwards. After the reduction confine the arm to the side, and support the forearm in a sling.

III. Dislocation of Both Extremities of the Clavicle.—M. Porral reports one case of this dislocation, and M. Goffres another. The latter happened in a woman from a fall between two rocks; there were ecchymoses upon the anterior and external faces of the right shoulder; the internal extremity of the right clavicle was incompletely luxated forwards, and the outer extremity upwards. The reduction was easily accomplished, but could not be maintained; and the patient was abandoned to her fate, the arm and forearm being supported in the scarf bandage of M. Mayor. At the end of forty days this was removed, and the patient resumed her occupation without the least restraint of motion of the arm, notwithstanding the persistence of the clavicular displacement.

Dislocation of the Humerus.

From the nature of the anatomical structure of the shoulder-joint, dislocation of the humerus is quite common. It may occur in one of three directions.

1. Downwards.
2. Forwards.
3. Backwards.

1. *Dislocation downwards.*—This is by far the most frequent variety, a fact readily explainable when the anatomical arrangement of the shoulder-joint is examined. The acromion and coracoid processes, with their ligaments, form a strong and resistant protection above, in front, and behind, while below there is nothing to prevent the head of the humerus slipping from the shallow glenoid cavity but the resistance offered by a thin capsular ligament, and by muscular contraction.

Causes.—The causes are direct force applied to the shoulder, as

happens in falls; blows upon the upper part of the arm; falls upon the elbow or hands when the arms are thrown forwards; and muscular action.

Mechanism.—When a blow is struck upon the shoulder, the head of the humerus is, of course, driven directly from the glenoid cavity; and, perhaps, in a majority of these instances, the arm at the time of the injury is more or less abducted.

Indirect force upon the hand or elbow luxates the head of the bone by making a lever of the first kind of the humerus, the fulcrum being formed by its tuberosity coming against the margin of the glenoid cavity, and the point of resistance by the anterior and inferior part of the capsular ligament, which is usually considerably torn in front of the tendon of the long head of the biceps; and even the latter is sometimes ruptured, allowing the head of the bone to escape from the capsule and take a position beneath the glenoid cavity upon the subscapularis muscle near the triangular space of the inferior border of the scapula.

Fig. 461.

Dislocation of the shoulder downwards.

The supra-spinatus, infra-spinatus, subscapularis, coraco-brachialis, and deltoid muscles are much stretched, and some of them, in certain cases, ruptured.

Symptoms.—The symptoms are: unusual prominence of the acromion process, and flattening of the deltoid muscle; the head of the humerus can be felt in the axilla; the arm separated from the chest slopes outwards and sometimes a little backwards, and cannot be brought in contact with it, though the arm may be moved to some extent forwards and backwards; it is also slightly longer than the other arm; the forearm is flexed a little upon the arm, and the patient cannot place the hand of the injured limb upon the opposite shoulder; the head and neck incline to the injured side. Crepitus is sometimes heard when the arm is moved, probably depending upon erosion of the cartilage of the joint, and should put the surgeon on his guard not to mistake it for the crepitus caused by a fracture.

Prognosis.—There will be no trouble in reducing a recent dislocation, and in many cases it has been effected after the lapse of weeks and even months, sometimes by manipulation, at others with certain mechanical contrivances.

If the injury to the joint has not been very severe, the arm will be

restored to its original usefulness, after reduction. In other instances, from extensive laceration of the capsule, rupture of the tendon of the

Fig. 462.

External appearance of dislocation of the shoulder downwards.

biceps, or the supra-spinatus, or from some other cause, the arm remains stiff, and its functions impaired for months; or it may even become paralyzed and atrophied from injury to the circumflex and other nerves.

In some cases the symmetry of the joint fails to be restored, the head of the humerus projecting considerably in front; and this may give rise to the supposition that the bone has been unreduced.

Treatment.—Many methods have been suggested by surgeons, for the reduction of dislocation of the shoulder, from the time of Hippocrates to the present moment.

The chief obstacle to the reduction is the tension of the muscles, in which the supra-spinous and deltoid are principally in fault. The simple plan of relaxing these two muscles by carrying the elbow away from the chest will often suffice alone to return the bone. M. Lacour directs the patient to be seated upon a stool, an assistant standing upon the uninjured side fixes the scapula with his hands; the surgeon now seizes the arm, bends the forearm at right angles with it, and makes extension, at the same time carrying the elbow from the body until the arm is at right angles with it; then using the forearm as a lever, he rotates the humerus rapidly inwards and brings the elbow to the chest, when the reduction will be completed.

Some difficulty has been encountered in effecting the reduction by extension in fixing the scapula so that it may become a fixed point of counter-extension. To remedy this objection, Desault and Boyer

advised the use of two bands to fix the shoulder, one crossing the acromion, and the other passing beneath the axilla; their ends were pulled in the opposite direction to that of extension and fastened to a wall.

For the same purpose Sir A. Cooper used an apparatus (Fig. 463) consisting of a broad band split at its centre to receive the shoulder, and having its two ends attached to a wall in the same manner as in the previous method; the extending belt is fastened around the lower

Fig. 463.

Sir A. Cooper's method of securing the scapula with a counter-extending band.

part of the arm above the elbow; the forearm is bent at right angles with the arm.

Dr. Nathan Smith, of New Haven, endeavored to fix the scapula by making the counter-extension from the opposite wrist, and his son, Prof. N. R. Smith, of Baltimore, combines the methods of his father and Sir A. Cooper; that is, he uses the counter-extending band seen in Fig. 464, and secures the wrist of the sound arm to it.

A plan was pursued by Sir A. Cooper of making the extension in the line of the body, while the heel was pressed into the axilla. (Fig. 465.) He placed "the patient in the recumbent posture upon a table or sofa, near to the edge of which he is to be brought. The surgeon then binds a wetted roller round the arm immediately above the elbow, upon which he ties a handkerchief; then he separates the patient's elbow from his side, and, with one foot resting upon the floor, he places the heel of his other foot in the axilla, receiving the head of the os humeri upon it, while he is himself in the sitting posture by the patient's side. He then draws the arms by means of the handkerchief, steadily, for three or four minutes, when, under common circumstances, the head of the bone is easily replaced; but if more force be required, the handkerchief may be changed for a long towel, by which several persons may pull, the surgeon's heel still remaining

Fig. 464.

Smith's method.

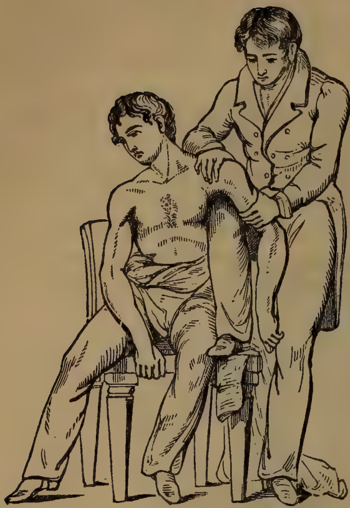
in the axilla. He generally bent the forearm nearly at right angles with the os humeri, because it relaxes the biceps, and consequently diminishes its resistance."

Fig. 465.

Sir A. Cooper's mode of making counter-extension with the heel.

This distinguished surgeon employed another method (Fig. 466), which, though not near so powerful as the preceding, will answer very

Fig. 466.

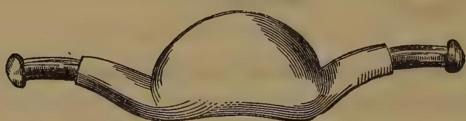


Sir A. Cooper's mode of reduction with the knee in the axilla.

well in those cases where the ligaments and muscles are much relaxed—as in delicate females. The patient is seated in a chair, the surgeon, standing behind him, and upon the injured side, places his foot upon the seat of the chair, with his knee forced well up into the axilla, and then steadying the shoulder with one hand, he grasps the arm with the other, and presses it forcibly downwards and inwards.

Mr. Skey believed that it was best to allow the scapula to have free play, so that the glenoid cavity may be drawn downwards, which he believes will contribute to the reduction. In the use of the pulleys he therefore discards the use of the band for fixing the scapula, and adopts a "well-padded iron knob (Fig. 467), which may represent the heel, from which there extend laterally two strong, straight branches of the same metal, each ending in a bulb or ring of about four inches in length, the office of which is designed to keep

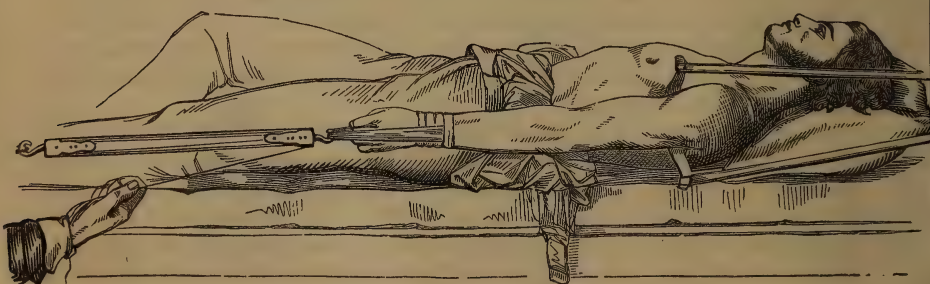
Fig. 467.



Skey's iron knob for the axilla.

the margins of the axilla as free from pressure as possible. The person of the patient should be placed on the back, or inclined over on to

Fig. 468.



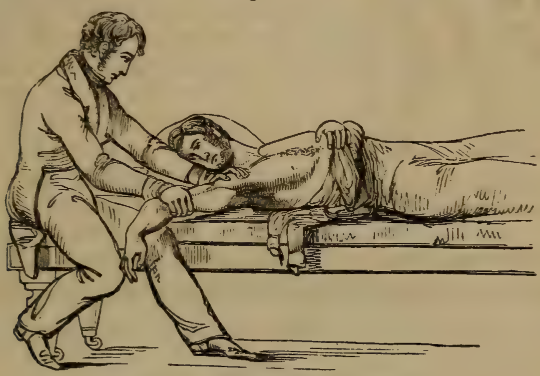
Skey's method of operating with the iron knob and pulleys.

the opposite side, and the cords passed up on each side of the shoulder, one in front and the other behind the joint (Fig. 468). The arm should be drawn downwards, as nearly as possible parallel to, and in contact

with, the body. Extension should be made from the wrist, and, especially in old cases, continued gradually. With the above plan he has succeeded in reducing a great many dislocations, whether occurring in very muscular men, or after some days or weeks, or even months' duration."

In the methods which we have now described, extension is made downwards in the line of the body, but the reduction may be accomplished by making extension upwards in the line of the body. This plan seems to have been practised by Brunus in the thirteenth century; by White, towards 1762; by Mothe, of Lyons, in 1776. While the arm is being extended, counter-extension is made by the hand, foot, or knee placed on the top of the shoulder. White, of Manchester, attached pulleys to the ceiling, and hoisted the patient from the ground by a fillet fastened to his wrist.

Fig. 469.



Mothe's method of reduction, modified.

Malgaigne directs a handkerchief to be bound to the patient's wrist, and its two extremities tied in a loop, which is thrown over the upper corner of a door, so that when the person raises his feet the weight of the body will be supported by the handkerchief.

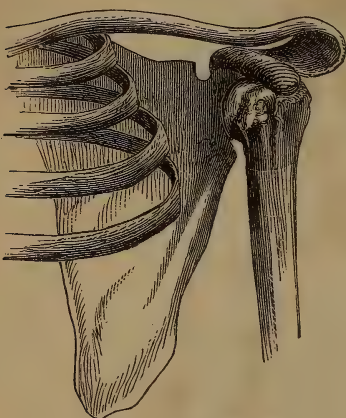
Jarvis's adjuster is a powerful instrument, and, manipulated with care, will be found exceedingly valuable in reducing old dislocations.

In all cases where any difficulty is encountered, it will be advisable to put the patient thoroughly under the influence of chloroform, both for the purpose of releasing him from pain, as well as to obtain complete muscular relaxation.

In making extension either with the hands or with pulleys, the direction should be nearly downwards—or certainly not higher than an angle of forty-five degrees, with a view to obviate the actions of the pectoralis major and latissimus dorsi. All jerking and traction in distorted lines can accomplish nothing but injury to the patient. Reduction of many ancient dislocations has been effected by Velpeau, Malgaigne, Gibson, and others; in these cases the redoubtable accidents to be feared are rupture of the axillary nerves and bloodvessels, inflammation of the tissues about the joint, and swelling and emphysema of the shoulder and axilla.

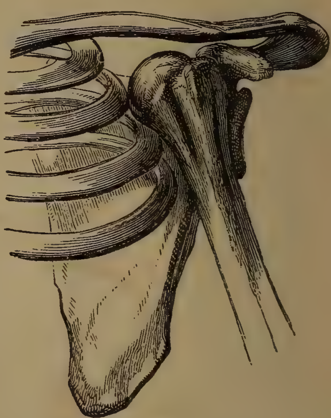
2. *Dislocation forwards.*—This kind of dislocation presents two species, according to the position assumed by the head of the humerus. In the first (subcoracoid), seen in Fig. 470, the head takes its position beneath the coracoid process, behind the tendon of the coraco-brachialis and short head of the biceps, and lies upon the subscapular mus-

Fig. 470.



Subcoracoid dislocation.

Fig. 471.



Subclavicular dislocation.

cle. In the second variety (subclavicular) (Fig. 471) the head rests beneath the clavicle, inside of the coracoid process, and behind the pectoralis major and minor muscles, upon that portion of the serratus magnus which covers the second and third ribs.

The capsular ligament will usually be much lacerated; and the deltoid, supra-spinatus, infra-spinatus, and subscapularis muscles much stretched, and the latter are sometimes ruptured.

Causes.—The cases are blows upon the posterior surface of the shoulder driving the head of the humerus forwards; falls upon the hands or elbow, particularly when the arms are inclined backwards; the continued action of a force upon the elbow after the head of the bone has been displaced in the axilla may shove the head either beneath the coracoid or clavicle; and lastly, muscular action.

Symptoms.—The acromion will project markedly, with a depression below, very evident a little posteriorly; the head of the humerus can be felt in the subclavicular fossa forming a distinct hard tumor, though in subcoracoid dislocation the tumor will be farther from the median line in front of the shoulder, as seen in Fig. 472; the elbow is close to the side of the body, and inclines backwards; the arm is slightly shortened, and cannot be moved without causing lively pain; neither the surgeon, nor the patient himself can place the hand of the injured arm upon the opposite shoulder; and lastly, the head and neck incline to the injured side.

Prognosis.—The prognosis in uncomplicated cases is as favorable as in the previous variety; but the reduction becomes much more difficult after the lapse of a few days.

Treatment.—The same principles of treatment hitherto described for

luxations downwards are applicable also in this variety. Both Velpeau and Malgaigne direct, as the most rational practice, that the arm be extended at right angles to the chest.

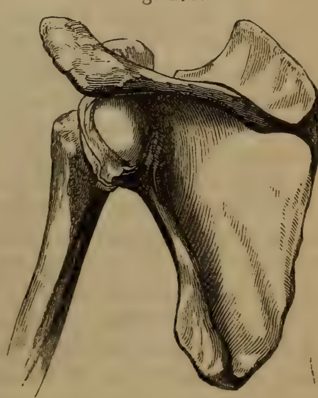
Fig. 472.

Subcoracoid dislocation.

3. *Dislocation backwards.*—It also presents two varieties. In one the head of the humerus takes a position beneath the acromion (subacromial), and in the other beneath the spine of the scapula (subspinous). It is a rare form of injury, and but few cases have been reported.

Causes.—It has happened chiefly from falls upon the elbow directed forwards, or upon the shoulder. The head of the humerus ruptures the capsular ligament at its posterior part, escaping between the tendon of the triceps and the inferior angle of the acromion, and either rests beneath this process, or passes further along under the spine, as seen in Fig. 473; the tendon of the subscapularis muscle being often ruptured. The head of the bone is covered in by the infra-spinatus, teres minor, and deltoid, though it sometimes happens that the head escapes between the two former, and is found beneath the deltoid only.

Fig. 473.



Subspinous dislocation.

Symptoms.—Subacromial depression will be well marked, and the coracoid

process will be seen prominent in front; the head of the humerus can be felt beneath the spine of the scapula; the elbow is close to the side, and projects forwards across the chest; the arm is slightly longer than the opposite one, and its movements are restrained, but not so much so as in the other varieties of dislocation.

Treatment.—In some cases the simple abduction of the arm has effected the reduction, while in others it will be necessary to rotate the arm inwards after abducting it.

M. Lacaussade succeeded perfectly by carrying the elbow backwards, while he pressed the head of the humerus strongly forwards.

Dislocations of the humerus may be complicated with fracture through its anatomical or surgical necks, of its tuberosities or of the coracoid or acromial processes, or lastly, of the glenoid fossa.

It may also be compound or complicated with injury to the axillary nerves and bloodvessels. In treating such complications, the general rule to follow is, where a fracture is present endeavor, if possible, to reduce the dislocation, and then treat the case as one of fracture. This cannot always be done, however; and the surgeon will be compelled to wait until the broken bones are united, and afterwards try to effect the reduction.

Aneurism and laceration of the axillary vessels are to be opposed, after reduction, by the means directed in general works on surgery.

Dislocation of the Radius and Ulna.

I. Dislocation of the Radius and Ulna.
  1. Backwards.
  2. Forwards.
  3. Outwards.
  4. Inwards.
  5. Radius forward and ulna backwards.

II. Dislocation of the Radius.
  1. Backwards.
  2. Forwards.
  3. Outwards.

III. Dislocation of the Ulna.
  a. Upper extremity.
    Backwards.
  b. Lower extremity.
    1. Forwards.
    2. Backwards.

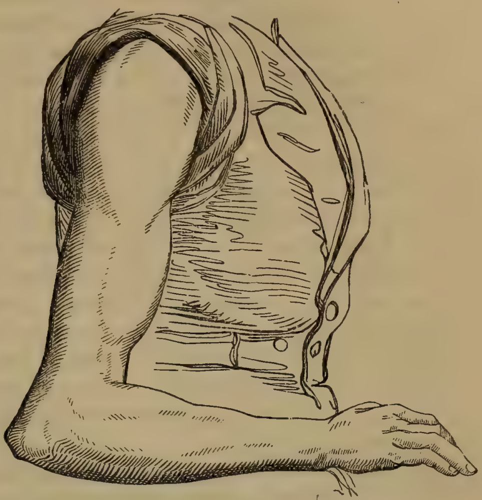
I. Dislocation of the Radius and Ulna.—1. *Dislocation of the Radius and Ulna backwards.*—It may be complete or incomplete; in the former case the coronoid process of the ulna occupies the olecranon fossa, while the head of the radius rests above the epicondyle. The condyles of the humerus force the brachialis anticus and the biceps strongly forwards, stretching and sometimes lacerating them; the brachial artery and median nerve are also pressed upon; the anterior and lateral ligaments are also usually torn through (Fig. 474).

Causes.—The causes are direct blows upon the upper and front part

of the forearm, or upon the lower and back part of the arm; and most commonly falls upon the hands or elbow while the arms are thrown

Fig. 474.

Fig. 475.



Dislocations of the radius and ulna backwards.

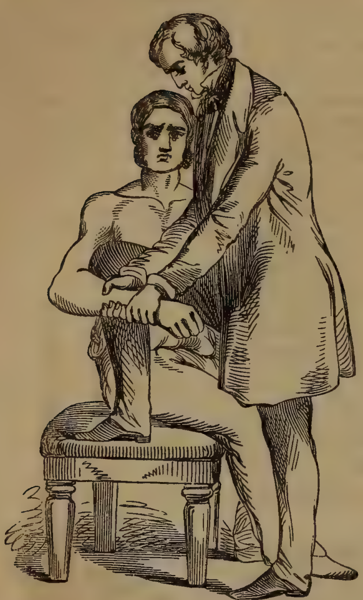
forwards; violent rotation and forced flexion of the forearm may also cause it.

Symptoms.—The forearm is somewhat flexed and shortened, and the functions of the elbow-joint nearly abolished; the hand is supinated and can be pronated but slightly; the olecranon process projects posteriorly and its tip will be some distance above a transverse line connecting the epicondyles; a tumor is formed in the bend of the elbow by the projecting condyles of the humerus (Fig. 475).

Prognosis.—In simple cases the reduction may be effected promptly, and it is rare for any bad consequences to follow if much injury has not been inflicted upon the joint; however, even after the bones are replaced, the motion of the joint will be much impaired, even if anchylosis does not follow.

Treatment.—There are several simple methods of reducing a dislocated elbow. The first is that practised by Nélaton: the forearm is to be bent at right angles with the arm, a short splint is bound to the posterior surface of the arm with its lower edge pressing against the olecranon; then the surgeon simply extends the forearm, when the splint will force the olecranon downwards towards its fossa. A second plan (Fig. 476), that recommended by Sir A. Cooper, consists in making the patient sit upon a chair, "and the surgeon, placing his knee on the inner side of the elbow-joint, in the bend of the arm, takes hold of the patient's wrist, and bends the arm. At the same time he presses on the radius and ulna with his knee, so as to separate them from the os humeri, and thus the coronoid process is thrown from the posterior fossa of the humerus; and whilst this pressure is supported by the

Fig. 476.



Reduction with the knee in the bend of the elbow.

knee, the arm is to be forcibly but slowly bent, and the reduction is soon effected."

The same object may be obtained by bending the arm around a moderate-sized stancheon, instead of the knee. Still a third way is sometimes had recourse to; the surgeon directs an assistant to make extension from the wrist, or, as Pirrie advises, from the middle of the forearm, drawing the arm straight, while he with his two thumbs presses the olecranon downwards, until the coronoid process is on a level with the trochlea; then he presses it directly forwards, the assistant, at the same time, being requested to flex the forearm.

When the reduction has been successful, the forearm can be extended and flexed without causing much pain or resistance; and there is little disposition of the bones to become reluxated in consequence of the peculiar anatomical arrangement of the joint surfaces. It will be necessary to simply support the forearm in a sling, and quell inflammatory action by the application of cold water-dressings or other antiphlogistic remedies, to the joint; at the end of eight or ten days commence passive motion to prevent anchylosis.

2. *Dislocation forwards.*—Some eminent surgeons, among whom we find Sir A. Cooper, deny the possibility of this luxation without a fracture of the olecranon process; but there are now some six well-authenticated cases upon record; so that it must be accepted as a possible accident. It is either incomplete or complete; in the former case the apex of the olecranon rests upon the trochlea, and in the latter, in front of this articular surface; usually the olecranon deviates to the right or left.

Causes.—The olecranon is thrown in front of the lower end of the humerus, by violent twisting of the forearm while the arm is either forcibly extended or flexed.

Symptoms.—In Velpeau's case the forearm was bent at right angles with the arm, and the elbow immovable; the rounded lower extremity of the humerus projected backwards in the place of the sharp-outlined olecranon; the forearm was strongly supinated and slightly shortened, the olecranon occupied a position upwards and outwards, while the head of the radius lay in the coronoid fossa.

Treatment.—When the tip of the olecranon rests upon the trochlea, reduction may be accomplished by either flexing or extending the forearm. In complete dislocation, forced flexion is necessary, and,

perhaps, extension from the wrist and counter-extension from the lower third of the arm.

3. *Dislocation of the Radius and Ulna outwards* (Fig. 477).—This is an unusual form of injury, and is either incomplete or complete: in the former instance the greater sigmoid notch embraces the depression separating the trochlea of the humerus from the external condyle, or it moves still further outwards and backwards; so that the coronoid process rests upon the posterior surface of the external condyle, while the posterior plane of the olecranon turns outwards, throwing the head of the radius forwards (dislocation backwards and outwards). In complete luxation both bones abandon completely the posterior and inferior surfaces of the humerus, moving outwards; the radius in most cases being thrown forwards or backwards, generally the former, in consequence of the annular ligament being ruptured.

Fig. 477.

Incomplete dislocation outwards.

In these cases the lateral ligaments are severely stretched, and, in complete luxation, ruptured; the fibres of the brachialis anticus and anconeus muscles suffer in a similar manner.

Causes.—The injury results from blows near the elbow upon the inner side of the forearm, or outer side of the arm; or from two forces operating upon these points in opposite directions; from falls upon the elbow or hands in the efforts of a person to prevent his body striking the ground; and from violently twisting the forearm.

Symptoms.—The elbow is increased in breadth, and there will be a notable prominence of the head of the radius upon its outer border, and a corresponding depression upon its inner border beneath the internal condyle; when the coronoid process is behind the condyle, the olecranon projects posteriorly and is above a horizontal line passing between the condyles; the motions of the elbow-joint are nearly abolished; the forearm is flexed upon the arm at an angle of about 135 degrees and strongly pronated, and appears to be twisted upon its axis; so that its inner surface looks posteriorly and the posterior surface outwards.

Prognosis.—The prognosis is of the same character as when the bones are dislocated posteriorly.

Treatment.—When the ulna takes a position behind the external condyle, the same manœuvres will be required as those described for posterior luxation. In complete dislocation, extension from the hand and counter-extension from the lower part of the humerus will be required, while the surgeon presses the bones with his fingers in opposite directions to their displacement. When the head of the radius is thrown forward upon the ulna, the forearm must be supinated before the extension is made.

4. *Dislocation of the Radius and Ulna inwards* (Fig. 478).—This is a still

rarer form of dislocation than the preceding, a fact depending, doubtless, upon the shape of the joint-surfaces—the trochlea sloping from within outwards offers more resistance to a force tending to drive the ulna towards the inner condyle. It may also be incomplete or complete; in the former variety, the sigmoid cavity embraces the inner condyle, and the head of the radius is drawn inwards beneath the trochlea, or the coronoid process moves back behind the inner condyle, and the head of the radius reposes in the olecranon fossa, as happens in some cases. In complete luxation, the bones are entirely separated from the lower and posterior surfaces of the lower end of the humerus.

Fig. 478.

Incomplete dislocation inwards.

The lateral ligaments are stretched or torn, and the fibres of the anconeus and tibialis anticus suffer more or less in the same manner. From the position of the olecranon over the course of the ulnar nerve this may be pressed upon or even crushed.

Symptoms.—The arm is bent, and the forearm generally strongly pronated; the external condyle is prominent; and from the absence of the head of the radius, a depression will be found below it; the head of the radius commonly remains beneath the trochlea, though it will sometimes form a tumor by projecting anteriorly in the bend of the elbow. The olecranon forms a prominence upon the inner side of the arm in the position of the epicondyle; if the coronoid process is behind the inner condyle, the forearm will be shortened. The prognosis and treatment are the same as for dislocation outwards.

5. *Dislocation of the Radius forwards, and the Ulna backwards.*—Three cases of this injury are recorded, and from them it may be gathered that the symptoms characterizing this luxation are a combination of those presented by dislocation of the radius and ulna separately, and that the treatment must be conducted upon the principles applicable to them.

II. DISLOCATION OF THE RADIUS. 1. *Dislocation of the Radius backwards.*—This is the most common form of the dislocations of the radius, and is not unfrequently associated with fracture of the condyles or of the upper end of the radius.

The head of the radius, rupturing the annular, oblique, and capsular ligaments, escapes from the lesser sigmoid notch, and takes up a position behind and to the external side of the outer condyle.

Causes.—The causes are falls upon the palms of the hands, while the forearm is strongly pronated; raising persons from the ground by the hand, particularly children; and finally, direct blows upon the front and outer margin of the forearm.

Symptoms.—The forearm is semiflexed and pronated; supination is impossible; flexion and extension limited and painful; the natural convex outline of the outer margin of the forearm is flattened; the

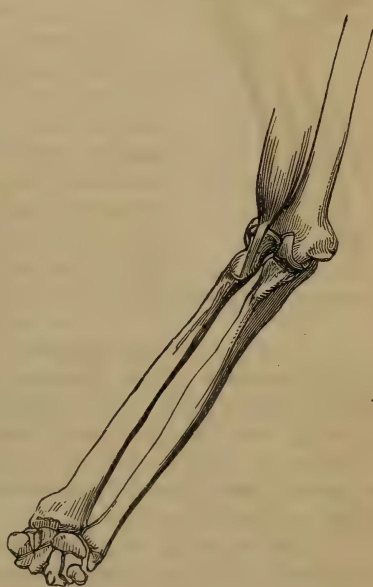
biceps tendon is tense; and the head of the humerus can be felt behind the outer condyle, beneath which there is a marked depression.

Treatment.—Make extension from the wrist, and counter-extension from the arm; then forcibly supinate the forearm; the reduction may be facilitated by making pressure upon the head of the radius from behind forwards with the thumbs. When the bone is restored to its natural position, the arm may be kept in a straight posture, the tendon of the biceps will thus be made to aid in maintaining the reduction; passive motion must be instituted in eight or ten days.

If accompanied with fracture of the inner condyle, Markoe recommends the arm to be supported by a splint, in a position about ten degrees less than a right angle.

2. *Dislocation of the Radius forwards* (Fig. 479).—In this luxation the head of the radius is thrown forwards upon the humerus; the anterior lateral and annular ligaments are more or less torn, though in some cases the latter may be only stretched. The dislocation is either incomplete or complete. Goyrand (*Annales de la Chirurgie Française,* 1842, vol. v. p. 129) describes the former as a slight displacement of the head of the radius forwards, occurring in children from being lifted from the ground by their hands, or being held by the hand when they stumble and fall.

Fig. 479.



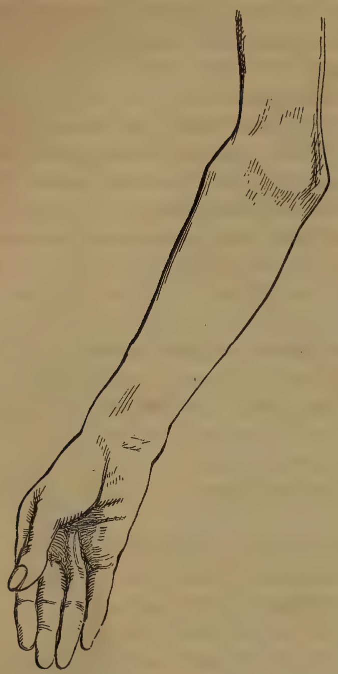
Dislocation of the radius forwards.

Causes.—The causes are, falls upon the palms of the hands, violent pronation of the forearm, a direct blow upon the upper and posterior part of the radius.

Symptoms.—When a child suffers from an incomplete luxation, it cries out immediately with pain of the arm, which is slightly bent and the forearm pronated; supination being impossible or extremely difficult; and the elbow is not swollen. In complete dislocation the head of the radius will be felt in the fold of the arm; there will be a depression beneath the external condyle; the curved outline of the radial border of the forearm will be flattened. Delpech states that the forearm will be generally found supinated; while Malgaigne and other surgeons regard pronation as the characteristic position. Certain cases have also been observed where the forearm was midway between pronation and supination; the arm is slightly bent, the tendon of the biceps relaxed, and flexion of the forearm beyond a right angle impossible.

Treatment.—Goyrand advises that extension should be made from the wrist with the surgeon's right hand, and counter-extension with the left,

Fig. 480.



External appearance of a dislocation of the radius forwards.

upon the lower part of the humerus, the thumb of this hand being placed upon the head of the radius. While extension is being made, supinate the forearm; then suddenly flex it as much as possible, the thumb pressing strongly outwards upon the radius all the time. Assistants may make the extension and counter-extension while the surgeon presses the head of the radius backwards with his thumb. Sir A. Cooper directs the arm to be supinated, while Denucé recommends the prone posture during extension.

The dislocation is apt to be reproduced when the forearm is extended, and it will be advisable, therefore, to place the arm in an angular splint, with a compress over the head of the radius.

3. *Dislocation of the Radius outwards.*—This is sometimes a primary luxation, but more commonly consecutive to either the anterior or posterior dislocations.

Symptoms.—The head of the radius forms a prominence outside of the epicondyle, giving a greater width, as well as a greater convexity to the upper part of the forearm, which is in a position midway between supination and pronation; complete supination being impossible, though extension and flexion can be performed.

Treatment.—The reduction may be effected by bending the arm at right angles, and making extension and counter-extension from the wrist and lower part of the arm; at the same moment the surgeon will press with his thumb the head of the radius downwards and inwards, to its normal position beneath the condyle of the humerus.

The bone is liable to slip out of position again in the movements of the forearm; and it will be necessary, in order to counteract this, to keep the arm in a flexed position, with a compress upon the outer side of the elbow by an angular splint, with bandages.

III. Dislocations of the Ulna. a. *Dislocation of the Upper Extremity of the Ulna.*—Dislocation of the ulna backwards may occur, though it is rare, and usually accompanied with fracture of the outer condyle of the humerus, or fracture of the neck of the radius.

Malgaigne states that the only peculiarity of this luxation is, that the head of the radius can be felt in its natural position, the other symptoms being the same as those of dislocation of both bones backwards. The reduction is also accomplished in the same manner as directed for this luxation.

b. *Dislocation of the Lower Extremity of the Ulna.* 1. *Dislocation of the lower end of the Ulna forwards.*—In this form of luxation the stylo-pisiform and capsular ligaments are torn, and the lower end of the ulna is thrown in front of the radius.

Causes.—Forced supination of the forearm.

Symptoms.—The arm is slightly bent; the forearm supinated; and the hand inclined to its radial border; the fingers are semi-flexed; there is a depression upon the inner side of the forearm above the wrist, caused by the ulna sloping across the lower part of the radius; the styloid process can no longer be felt in its prominent position upon the inner border of the wrist, which is diminished in width, and rounded; and lastly, the point of the ulna forms a tumor in front of the radius.

Treatment.—The bone may be restored to its natural position in the following manner: The surgeon seizes the forearm in both his hands, with the thumbs placed between the bones, and the fingers steadying the radius; and while an assistant pronates the forearm he shoves the ulna in position with his thumb. If there is any disposition of the ulna to become reluxated, two padded splints may be confined to the forearm with a roller bandage.

2. *Dislocation of the Lower End of the Ulna backwards.*—This is exactly the reverse of the preceding luxation; the distal extremity of the ulna is thrown upon the posterior surface of the radius.

Causes.—It is caused by violent pronation of the forearm.

Treatment.—The arm will be found slightly bent, and the forearm pronated; the hand and fingers are semi-flexed; the point of the ulna forms a tumor on the back of the wrist, which is diminished in width by the overlapping of the two bones below.

Treatment.—The same manipulation may be employed in this case as in dislocation forwards, with this difference, that as the surgeon presses the ulna inwards with his thumbs, the assistant must supinate the forearm.

Dislocation of the Carpus upon the Radius and Ulna.

Dislocation of the Carpus—

1. Backwards.
2. Forwards.

1. *Dislocation of the Carpus backwards* (Fig. 481).—The causes of this injury are direct violence inflicted upon the wrist, driving the carpus backwards, and falls upon the hands in a flexed position. The carpus is forced upon the posterior surface of the radius under the extensor tendons, which are stretched over its upper extremity; the ligaments of the wrist-joint are more or less torn; and the arteries, nerves, and muscles in the neighborhood bruised. The dislocation is sometimes compound, and at others complicated, with a fracture of the lower end of the radius or ulna.

Symptoms.— The forearm is shortened when measured from the olecranon to the tip of the middle finger, while the distance between the former point and the styloid process remains unchanged; there is a large prominence formed by the carpus upon the back of the fore-

Fig. 481.

Dislocation of the carpus backwards.

arm, and another in front, caused by the lower projecting ends of radius and ulna, below which there is a well-marked depression; the styloid processes are not in the same line as the carpal bones; the wrist is much thicker than natural, and the fingers are semi-flexed.

Treatment.—Compound dislocation of the wrist often requires amputation or resection; but perfect rest, cooling lotions, and other antiphlogistic remedies will accomplish much in some of these cases in securing a favorable issue without operation; though anchylosis and excessive inflammation with profuse suppuration are at all times to be feared.

The carpus may be restored to its articular relation by directing an assistant to make counter-extension from the forearm, while another grasps the metacarpus and effects extension; the surgeon then endeavors to push the carpus downwards with his thumbs.

Malgaigne states that in the above plan the hold upon the metacarpus is not sufficiently firm, at the same time it puts the skin on the stretch and opposes in some measure the reduction. His method is to make the extension by grasping the last four fingers, and with a lac fastened around the metacarpus above the roots of the fingers.

Fig. 482.

Dislocation of the carpus forwards.

2. *Dislocation of the Carpus forwards* (Fig. 482).—In this variety of dislocation the carpus is thrown forwards upon the anterior face of the radius.

The causes, symptoms, and treatment are the reverse of those of dislocation backwards.

Dislocation of the Carpal Bones upon each other.

The carpal bones are so strongly bound together by ligaments, and protected by the tendons crossing them at the wrist, as well as possessing such a limited range of motion, that a simple dislocation is rather of an uncommon occurrence.

The os magnum is thrown backwards by falls upon the back of the hand, violently flexing it. I saw a case of a young lady who fell from her horse upon the hand. A tumor was observed upon its back, which could be made to disappear by firm pressure upon it, but returned immediately when the hand was flexed; a compress was placed over the os magnum, and two straight splints upon the forearm secured by a roller bandage; after the treatment the wrist remained weak for several months, and there was a slight prominence at the seat of the injury.

Should simple pressure not suffice to reduce the bone, extension should be made at the same time from the index and middle fingers.

Sir A. Cooper states that both the os magnum and cuneiform may

be displaced backwards from relaxation of the ligaments; and in the case of a young lady in whom it occurred, she was compelled to wear two short splints to strengthen the wrist; for the same purpose another lady wore a broad steel-chain bracelet clasping the wrist tightly.

Mr. Erichsen saw the case of a patient who fell from a height, injuring the spine and doubling the right hand under him. "On examining the wrist, a small hard tumor was felt projecting on its dorsal aspect, which usually disappeared on extending the hand and employing firm pressure, but started up again so soon as the wrist was forcibly flexēd. It was evident that this bone belonged to the first row of the carpus, articulating with the radius; and from its size, its position towards the radial side of the carpus, and its shape, which could be distinctly made out through the integuments, there could be little doubt that it was the semilunar bone."

Fergusson says: "I have known of one example in which the pisiform bone was detached from its lower connections by the action of the flexor carpi-ulnaris. Little benefit can be expected from any attempt to keep this bone in its proper position, nor, indeed, is the displacement of much consequence."

South states that the unciform is sometimes thrown backwards by the relaxation of the ligaments, and forms a projection on the back of the hand when it is flexed. The hand cannot be used without the wrist is supported, and he directs for this purpose the application of strips of adhesive plaster and a bandage.

Dislocation of the Metacarpus.

The limited amount of motion enjoyed by the metacarpal bones, their arrangement in a parallel row with their proximal extremities supporting each other like wedges, and bound together by strong ligamentous fasciculi passing between them and the carpus, render dislocation at the carpo-metacarpal articulation uncommon.

The first metacarpal bone, from its exposed position upon the outer border of the hand, and the greater extent of motion possessed by it, is more frequently dislocated than any of the others.

The luxation may occur backwards, or forwards and inwards.

1. *Dislocation of the First Metacarpal Bone backwards.*—This injury is caused by a force applied to its lower extremity, forcing it upwards and generally throwing the thumb into forced flexion; it has also been produced by violence acting upon the anterior aspect of the bone.

The ligaments surrounding the joint are more or less ruptured, and the proximal extremity of the bone is thrown upon the posterior surface of the trapezium.

Symptoms.—There is a protuberance formed by the end of the bone upon the back of the hand; the thumb is generally flexed and inclined across the palm of the hand, and its motions abolished.

Treatment.—The reduction is accomplished by making extension and counter-extension, and at the same time pressure downwards upon the displaced bone; then apply a narrow splint, with a compress over the joint, upon the outer margin of the hand and wrist, if there is any tendency to reluxation.

2. *Dislocation of the First Metacarpal Bone forwards and inwards.*—Here the proximal end of the bone lies in front of the carpus between the trapezium and the root of the second metacarpal bone.

Symptoms.—A tumor is formed in front towards the palm of the hand; the thumb is thrown outwards, and its tip cannot be brought in contact with the point of the little finger, nor can it be adducted.

The reduction may be attempted by making extension and gradually carrying the thumb towards the palm of the hand; pressure outwards upon the root of the bone may be made at the same time.

3. *Dislocation of the Outer Four Metacarpal Bones.*—M. Bourguet has reported a case of luxation of the second metacarpal bone forwards, and Blaudin and Roux, each, one of the third metacarpal bone backwards.

Dr. Hamilton relates two cases of an incomplete posterior luxation of the second and third metacarpal bones at the same time by the patient's striking a blow with the clenched fist.

The symptoms are pain, swelling, and deformity over the carpo-metacarpal articulation.

Treatment.—Extension from the finger of the displaced metacarpal bone, combined with pressure upon its proximal extremity.

Should there be any disposition to a recurrence of the displacement, a straight splint with the necessary compresses should be applied to the hand.

Dislocation of the Phalanges.

A. Dislocation of the First Row of Phalanges.—Dislocation of the first phalanx of the thumb is more frequent than any other, and may be complete or incomplete. It occurs backwards or forwards.

1. *Dislocation of the First Phalanx of the Thumb backwards.*—This happens more frequently than in a forward direction. It is caused by any force doubling the thumb back upon the hand. When the luxation is complete, the proximal end of the first phalanx takes a position behind the adjoining extremity of the metacarpal bone and at right angles with it, while the second phalanx is flexed and forms an angle with the first, so that the shape of the thumb will represent somewhat the letter Z, as seen in Fig. 483; the distal end of the first metacarpal bone forms a tumor in front of the thumb looking towards the palm. Sometimes, however, the first phalanx and the metacarpal bone lie in parallel positions, and this characteristic shape of the thumb will not be seen, and the tumor spoken of above as looking towards the palm will then present itself upon the posterior aspect of the thumb.

Fig. 483.

Dislocation of the first phalanx of the thumb backwards.

Symptoms.—These changes of outline of the thumb, with abolition of its functions, will render the identification of the injury easy.

Prognosis.—The reduction of this dislocation in recent cases is sometimes effected with ease; but there are cases in which great difficulty will

be encountered from some peculiarity in the nature of the injury, which has not as yet been certainly and satisfactorily explained. Some surgeons attribute it to the rupture and interposition of the anterior ligament between the joint-surfaces; Hey to the lifting of the lateral ligaments over the end of the metacarpal bone which is constricted by them, and some again charge the difficulty to the muscles; Vidal de Cassis says the distal extremity of the metacarpal bone is constricted between the two heads of the short flexor of the thumb; there are others who think that the bones are at fault, and that the obstacle to reduction is the interlocking of the margins of their articular surfaces.

Treatment.—There are various methods recommended for the reduction of this dislocation; some consisting in simple manipulation with the fingers, and others in the application of apparatus for extension.

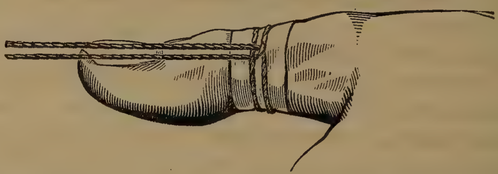
In the ordinary process by manipulation the surgeon presses the distal extremity of the first phalanx upwards so as to throw its articulating surface in the direction of the farther end of the metacarpal bone; then supporting the phalanx in this position with the fingers, and pressing against the distal end of the metacarpal bone, the thumbs are forcibly pressed against the base of the displaced phalanx to throw it into its natural position. Dr. Batchelder, of New York, has improved this method in some particulars worthy of special notice. He directs the surgeon "to take the metacarpal portion of the dislocated thumb between the thumb and finger of one hand, and flex, or force it, as far as may be, into the palm of the hand, for the purpose of relaxing the muscles connected with the proximal end of the phalanx, particularly the flexor brevis pollicis. He should then apply the end of the thumb of this hand against the displaced extremity of the dislocated phalanx for the purpose of forcing it downwards, and at the same time grasp the displaced thumb with his other hand, and move it forcibly backwards and forwards, as in strongly forced flexion and extension, the pressure against the upper extremity of the first phalanx being kept up. In this way the dislocated bone may be made to descend, so as to be almost or quite on a line with the articulating surface of the metacarpal bone, when the thumb may be forcibly flexed; and, if it be not reduced, is forcibly extended, and brought backwards to a right angle with the metacarpal bone; when, if the downward pressure with the thumb, placed as before directed for that purpose, has been continued (which thumb, by maintaining its position, acts as a fulcrum, as well as by its pressure), the bone will slip into its place, and the reduction be effected."

Should these manipulations not succeed, extension may be had recourse to (Fig. 484). For this purpose, Sir A. Cooper recommended that the thumb be adducted, to relax the muscles connected with the proximal extremity of the phalanx; a piece of soft leather was wrapped around this phalanx, and over this a lac is fastened by the clove-hitch; the surgeon, grasping the ends of the lac, will be enabled to make the required amount of traction, while an assistant seizes the hand of the patient with his fingers placed between the thumb and radial border

of the palm, and makes the counter-extension; or some wool may be put between the finger and thumb, and a counter-extending band be used.

Another plan of this surgeon was to attach a weight to the lac running over a pulley.

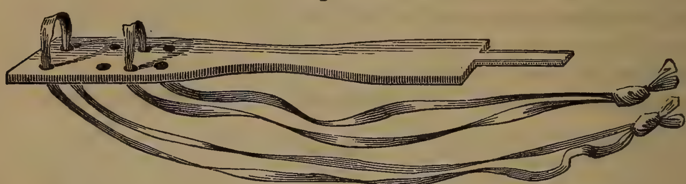
Fig. 484.



Sir A. Cooper's method of making extension with a weight in dislocation of the thumb.

A much more efficient way of making extension and of getting complete command over the thumb is with a very simple instrument contrived by Dr. Levis, of Philadelphia. It consists of "a thin strip of hard wood, about ten inches in length, and one inch, or rather more, in width. One end of the piece is perforated with six or eight holes.

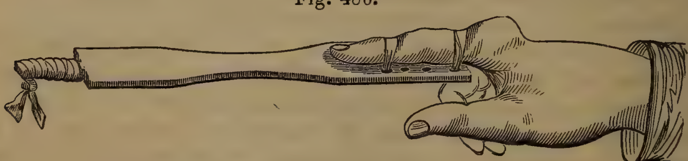
Fig. 485.



Levis's instrument for reducing dislocation of the phalanges.

The opposite end is partly cut away, forming a projecting pin, and leaving a shoulder on each side of it. Towards this end of the strip a sort of handle shape is given to it, so as to insure a secure grasp to the operator. Two pieces of strong tape or other material, about one yard in length, are prepared. One of these is passed through the holes at the end of the strip, leaving a loop on one side. The other tape is passed through another pair of holes, according as it may be

Fig. 486.



Levis's instrument applied.

a thumb or finger to which it is to be applied, or varied to suit the length of the finger, leaving a similar loop. If a dislocated thumb is to be acted on, the second tapes should be passed through the holes nearest the first. The ends of each separate tape are then tied together."

He directs the apparatus to be applied "by passing the finger through the loops. The loop nearest the first joint is then tightened by drawing on the tape, which is then brought along the strip to the opposite end, across one of the shoulders, and secured by winding it firmly around the projecting pin. The other tape is tightened in a like manner, crossing the other shoulder, and winding around the pin in an opposite direction; when, for security, the ends of the tapes are finally tied together."

The same end, that of securing complete control over the motions of the thumb, was kept in view by Luër, of Paris, in constructing his forceps for the reduction of dislocated phalanges. The points of the forceps are bifurcated; between each pair of which a piece of strong cloth or canvas is stretched, to grasp the thumb firmly; additional power may be gained by placing inside of the canvas two pieces of cork or caoutchouc.

Charrière, of the same city, contrived a pair of forceps for the same purpose; they were articulated at one extremity, in the same manner as an ordinary pair of dividers, and divided at the other into four prongs, to which four leather straps are attached in such a manner as to make two slip-knots, in which the thumb is to be placed, and held firmly by pressing upon the forceps.

Dr. Hamilton suggested the employment of a toy called the "Indian puzzle," for making extension upon dislocated fingers. It "is an elongated cone of about sixteen or eighteen inches in length, made of ash splittings, and braided; the open end of the cone being about three-

Fig. 487.

"Indian puzzle," employed for the reduction of dislocations of the phalanges.

fourths of an inch in diameter, and the opposite end terminating in a braided cord. When applied to the finger, it is slipped on lightly, forming a cap to the extremity, and to half the length of the finger; but on traction being made from the opposite end it fastens itself to the limb with a most uncompromising grasp."

With a view of making extension, and at the same time of flexing and extending the thumb Vidal de Cassis employed a common door key. He placed the ring over the dislocated thumb so that its palmar surface reposed upon the stem of the key, while that part of the circumference of the ring opposite the stem rested against the dorsal face of the proximal extremity of the first phalanx. Seizing the key in the right hand, the thumb is forced into a position of dorsal flexion, at the same time sliding the articular surface of the phalanx in the direction of the articular surface of the metacarpal bone, when sudden flexion of the thumb will replace the bone in its natural position.

Lastly, Malgaigne and Blandin have employed, in obstinate cases, a

sharp-pointed metallic stem, which they forced through the skin between the articular surfaces of the phalanx and metacarpal bone, and prized the former into its natural position.

In some of these cases, which resist all the efforts of the surgeon at reduction, the subcutaneous division of the lateral ligaments is required.

When the bone has been restored to its natural articular connections, inflammatory action should be combated by appropriate antiphlogistic measures; and, to prevent the luxation recurring, a splint may be applied, and secured to the parts by the spica of the thumb.

2. *Dislocation of the First Phalanx of the Thumb forwards.*—This form of dislocation is rare, and but few cases are recorded. It is caused

Fig. 488.

Dislocation of the first phalanx forwards.

by blows upon the back of the phalanx, the proximal extremity, of which is driven in front of the metacarpal bone, forming a prominence in front. The phalanx and metacarpal bone are usually in parallel positions.

Treatment.—The reduction is effected by seizing the thumb in the palm of the right hand and making extension, while the thumb of this hand makes counter-pressure upon the head of the metacarpal bone. If this plan fails, the phalanx should be flexed firmly towards the palm. In the cases reported no difficulties have been encountered in the reduction.

3. *Dislocation of the First Phalanges of the Fingers.*—Dislocation of the first phalanges of the fingers is an uncommon injury. It may occur forwards or backwards, and be complete or incomplete.

It is caused by blows upon the ends of the fingers, and is readily

Fig. 489.

Reduction of dislocation of the phalanx backwards by extension.

recognized by the deformity produced at the metacarpo-phalangeal articulation.

Treatment.—Extension from the finger will effect the reduction, as

seen in Fig. 489; or forced flexion in forward luxation, and the reverse in backward luxation will also be found efficient.

B. Dislocation of the Second and Third Rows of the Phalanges.—The phalanges of the second and third rows of the fingers

Fig. 490.

Dislocation of the second phalanx backwards.

and thumb may be dislocated forwards or backwards. It is caused by blows upon the tips of the fingers, and is easily recognized by the deformity of the phalangeal joints.

The treatment is the same as for dislocation of the first phalanges.

SECTION III.

DISLOCATIONS OF THE LOWER EXTREMITIES.

Dislocation of the Pelvic Bones.

From the strength of the articulations of the pelvis, dislocation of its component bones is of extremely rare occurrence; and, when it does happen, the amount of violence necessarily inflicted will generally produce fatal injury of the pelvic and abdominal organs. The luxation is always incomplete.

Boyer relates a case of dislocation of the left ileum upwards by a fall from a height. The anterior superior spinous process was above the level of the corresponding point upon the opposite side; the left pubis was some distance above the right; the left leg was shorter than the right, but both of them measured the same length from the trochanter to the ankle; flexion and extension of the thigh gave rise to pain in the pubic and sacro-iliac symphyses.

A disturbance of the relation of the two bones has been observed, also, after difficult labor; the patient cannot walk without great pain, from the motion of the bones at the symphyses, and requires the application of a broad bandage to the pelvis and hips to hold the bones in firm apposition.

The sacrum may be driven slightly inwards by a violent blow upon the back of the pelvis, and the coccyx, before ossification, may be incompletely dislocated either forwards or backwards. In the former case, it results from blows or falls upon the part; and in the latter case, from the pressure of the head of the child in difficult labor.

The reduction is easy. Introduce the point of the index finger into the rectum, and grasp the coccyx between the thumb and finger, pressing it in a direction opposite the displacement. There is no disposition to reluxation.

Dislocation of the Femur.

The coxo-femoral joint is one of exceeding strength, the large globular head of the femur being held in a deep osseous cavity by strong ligaments, and protected by a mass of muscles surrounding the articulation, presenting a most perfect type of the ball-and-socket joint, which allows a wide range of motion.

The dislocation usually occurs in four principal directions, backwards and upwards upon the dorsum ilii; backwards and upwards into the sciatic notch; forwards and downwards into the thyroid foramen; and forwards and upwards upon the pubic bone. From some peculiarity in the application of the force producing the injury, or from some other cause, it occasionally happens that the head of the femur passes in any direction intervening between these four, so that it has been found under the anterior-superior spinous process, in the lesser ischiatic foramen, upon the posterior part of the body of the ischium, below the lower margin of the acetabulum, and in the perineum.

As to the relative frequency of the four principal varieties, Cooper and Malgaigne state it in the order in which they are mentioned above. It is most commonly met with in persons between the ages of twenty and forty-five, being rare in childhood and old age. Males suffer more often than females in the proportion of eight to one.

1. *Iliac Dislocation.*—Iliac dislocation, or that where the head of the bone reposes upon the dorsum of the ilium, is caused by falls upon the knee or foot when the thigh is adducted, and somewhat in

Fig. 491.

Iliac dislocation. Anatomical relation.

Fig. 492.

Iliac dislocation. External appearances.

advance of the body; or by blows upon the back of the pelvis when a person is stooping, with the knees widely separated.

The capsular ligament is ruptured, particularly at its posterior part, and the head of the femur is thrust upwards on the dorsum of the ilium among the fibres of the gluteal muscles, which are relaxed and folded upwards, while the adductor muscles are drawn tense. When the injury is severe, there will be more or less contusion and effusion of blood into the soft parts about the joint.

Symptoms.—The patient cannot support the weight of the body upon the injured limb, which will be found, upon measurement from the anterior-superior spinous process of the ileum to the malleolus, from an inch and a half to three inches shorter than the other, the average being two inches, and cannot be drawn to its normal length by moderate extension; the thigh is rotated inwards, so that the knee touches the sound thigh just above the patella, and the great toe rests upon the instep of the opposite foot, as seen in Fig. 492; or upon the foot just below it. The trochanter is more prominent, and nearer the spine of the ilium, and in some persons the head of the femur can be felt in its abnormal position; flexion is easy, adduction less so, and abduction is impossible.

Diagnosis.—Dislocation can be distinguished from fracture of the upper extremity of the femur by the following features: The shortened limb cannot be restored to its normal length by moderate extension; the toes are turned in; motion of the thigh at the hip much restricted; and crepitus is absent. In fracture, these symptoms are exactly the reverse.

Prognosis.—Dislocation of the femur is always a serious matter, though usually, in simple cases, where the reduction has been accomplished, the limb, in two or three months, will become as strong as the sound one. Sometimes, again, it remains stiff and weak for months; and in severer cases, occasionally inflammation of a chronic character will arise, producing ulceration of the cartilages and caries of the bone; or even acute inflammation may occur, followed by abscess.

Treatment.—The dislocation may be reduced by *manipulation,* or by extension and counter-extension. In the first instance, chloroform having been administered, if deemed necessary, the patient is placed upon his back on a couch—or, better still, upon the floor, which will enable the surgeon to have greater command over the limb; he now seizes the knee of the injured limb in one hand, and the ankle in the other, and bends the leg upon the thigh; then the knee is carried across the opposite thigh upwards in the direction of the corresponding side to the umbilicus, when it should be made to sweep across the abdomen to the injured side. From this position the thigh is gradually brought down or extended, the knee being pressed outwards, while the foot is conducted across the sound limb, until the thighs are side by side.

In Fig. 493 the arrows and dotted lines indicate directions pursued by the knee and the head of the femur.

It will be found that the reduction takes place when the thigh begins to descend from a right angle with the body; and should it not occur at this time the movement may be recommenced.

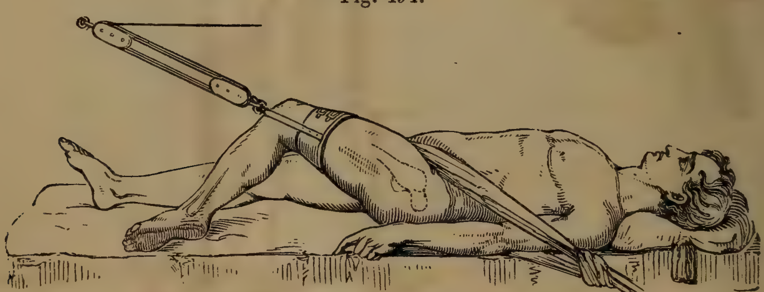
Should a resort to the pulleys be determined on, the patient should be placed on his back upon a narrow table. and thoroughly *chloro-*

Fig. 493.

Diagram showing the mechanism of reduction of the hip by the *flexion method.*

formed. An extending band is fixed upon the lower part of the thigh, which may be the ordinary leather strap with buckles, applied over a wetted roller, or two pieces of some strong cloth, two feet long and about four inches wide, laid upon the sides of the limb, and secured above the knee by a wetted roller. The ends of the strips are then knotted together to form a loop upon each side of the thigh. The counter-extending band is prepared by rolling up a sheet into a cord, the centre of which is placed in the perineum, and its extremities brought upwards over the hip of the injured side, to be fastened to a staple fixed in the wall. The pulleys are to be hooked at one end to a staple driven into the wall at an opposite point, and at the other to the extending band in such a manner that the extending and counter-extending forces shall act in opposite directions in the axis of the femur. The thigh of the injured limb should be bent some-

Fig. 494.



Method of reducing dislocated hip with pulleys.

what upon the abdomen, so as to point across the opposite leg just above the knee, as seen in Fig. 494.

An assistant should stand by the table, and with his hands steady the patient's hips; a second assistant takes hold of the leg to rotate the thigh gently, when so directed by the surgeon, who takes his position at the hip of the injured side, with a strip of muslin passing around his neck and the upper part of the thigh, by means of which he raises the head of the bone, when it is brought down to the acetabulum. The force applied to the pulleys should be gentle and continuous, in order to gradually fatigue and extend the muscles; quick pulling or jerking upon the cord will add to the difficulties of the reduction by stimulating them to stronger contraction.

The after-treatment consists in keeping the patient in bed with his thighs tied together, the injured one being rotated a little outwards, for fifteen or twenty days.

Fig. 495.

Anatomical relation of sciatic dislocation.

Fig. 496.

External appearance of sciatic dislocation.

2. *Sciatic Dislocation.*—Sciatic dislocation, or that in which the head of the femur rests in the sciatic notch (Fig. 495), is caused by falls or

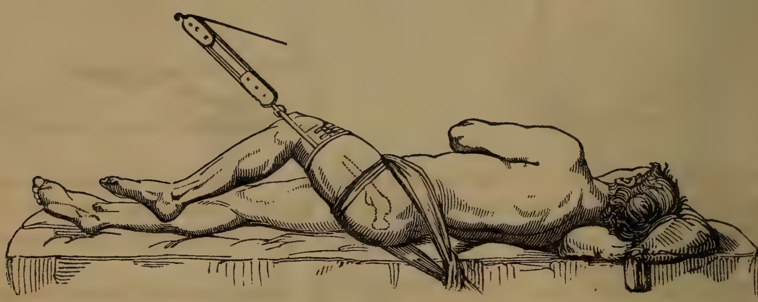
blows upon the knees or feet when the thighs are strongly flexed upon the abdomen, or the body upon the thighs.

The capsular ligament is ruptured at its posterior part, the teres ligament torn through, and the psoas-magnus, iliacus internus, and obturator muscles tensely stretched.

Symptoms.—The symptoms of this dislocation are similar to those of the iliac variety; the limb will be shortened from half an inch to an inch; the thigh flexed, and the knee projecting in front of the cpposite one, but not so much as in iliac luxation; the toes rest upon the ball of the toe of the other foot (Fig. 496); the trochanter is farther off from the crest of the ilium, and the head of the bone can be rarely felt in its new position; the thigh is immovable; and, according to Mr. Syme, there is "an arched form of the lumbar part of the spine, which cannot be straightened so long as the thigh is straight, or on a line with the patient's trunk. When the limb is raised or bent upwards upon the pelvis, the back rests flat upon the bed; but as soon as the limb is allowed to descend, the back becomes arched as before."

Treatment.—The method of reduction by flexion is the same as in the previous case. In the application of the pulleys the patient should be placed upon the sound side, and after having arranged the extending and counter-extending bands in the manner already pointed out, the line of traction should be made across the middle of the opposite thigh, as seen in Fig. 497, until the muscles are sufficiently fatigued to permit the head of the bone to be dislodged from the

Fig. 497.



Method of reducing sciatic dislocation with pulleys.

sciatic notch, when it must be pulled forward to the acetabulum by the lac placed around the upper part of the thigh and over the surgeon's neck.

The after-treatment is the same as in the former case.

3. *Thyroid Dislocation.*—This is caused by force applied to the knee or foot while the limb is abducted and posterior to the plane of the body; or by heavy weights falling upon the loins or hips while the body is bent forwards and the legs widely separated.

The teres and capsular ligaments (the latter notably upon its inner side) are ruptured, and the head of the femur escapes from the coty-

loid cavity, and assumes a position upon the external obturator muscle over the thyroid foramen, the trochanter looking towards the acetabulum (Fig. 498).

Symptoms.—The thigh is slightly flexed and the body bent forwards in consequence of the psoas muscle being put upon the stretch; the limb is lengthened one or two inches, and abducted; efforts to abduct,

Fig. 498.

Thyroid dislocation.

Fig. 499.

External appearances of thyroid dislocation.

extend, and rotate it, are extremely painful; while the former movement is impossible; the foot is generally turned forwards; the hip is flattened, and the head of the femur can be felt at the upper and inner surface of the thigh (Fig. 499).

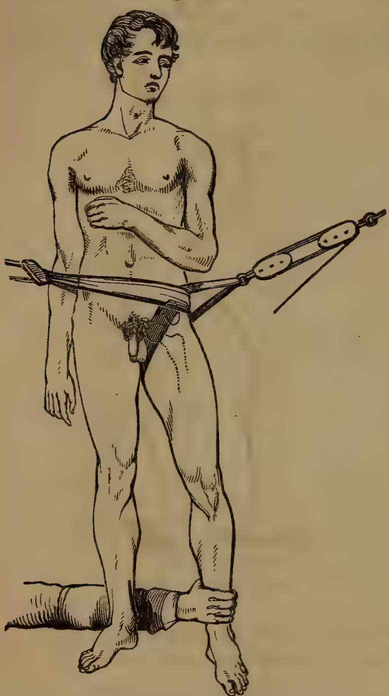
Diagnosis.—The immobility of the thigh, abduction and lengthening of the limb, the turning forwards of the toes, and flattening of the nates will so characterize this dislocation as to prevent its being mistaken for fracture of the neck of the femur.

Treatment.—The *flexion* method may also be applied in this case. The thigh is flexed, and, in bringing it down again, instead of rotating it outwards as in the former cases, it must be rotated inwards, so as to throw the head of the bone towards the acetabulum. It should be remarked, however, that, in certain cases recorded, the reduction was accomplished by outward rotation.

Sir A. Cooper's plan with the pulleys is to be conducted in this manner: Place the patient on his back; around the upper part of the thigh put an extending band, to which the pulleys are hooked by

one of its extremities, the other being attached to a point in the wall opposite the injured hip; the counter-extending band is passed around the hips, and through the noose of the extending lac, and drawn over to the sound side to be fixed to a corresponding point in the opposite wall (Fig. 500).

Fig. 500.



Reduction of thyroid dislocation by pulleys.

Force is now applied to the pulleys to extricate the head of the femur from the thyroid foramen, when the surgeon, passing his hand behind the sound limb, seizes the ankle of the opposite one and draws it towards him, making a lever of the first order of the injured limb to throw the head of the bone towards the acetabulum, when the extending pulleys should be loosened, and the reduction will be effected.

4. *Pubic Dislocation* (Fig. 501).—This is the rarest of the four varieties. It is caused by forces acting in the same manner as in thyroid luxation; and particularly when the limb is thrown very much in the rear of the body at the time of the injury.

The capsular ligament is ruptured at its inner and upper portion, the head of the femur escapes and slips upwards upon the pubis outside of the pectineal eminence under cover of the psoas magnus and iliacus internus.

Symptoms.—The limb is shortened about an inch and abducted; the movements of adduction and rotation cannot be executed; the toes turn out (Fig. 502); the head of the bone can be felt in the groin below Poupart's ligament; the hip is flattened; and the fold separating the femoral and gluteal regions higher up than it is upon the sound side.

Treatment.—The reduction was effected in a case by Malgaigne in the following manner: The thigh was flexed upon the abdomen, abducted a little, then rotated inwards, and finally brought down adducted.

In using the pulleys the patient is placed upon his back, the counter-extending band is fixed in the wall above the table, and the pulleys to an opposite point below it; then with the thighs widely separated, the forces are made to act in opposite directions in the line of the axis of the thigh, as seen in Fig. 503. When the head of the bone is moved from its position, it may be lifted into its socket by a towel passing around the upper part of the thigh and around the neck of the surgeon.

Fig. 501.

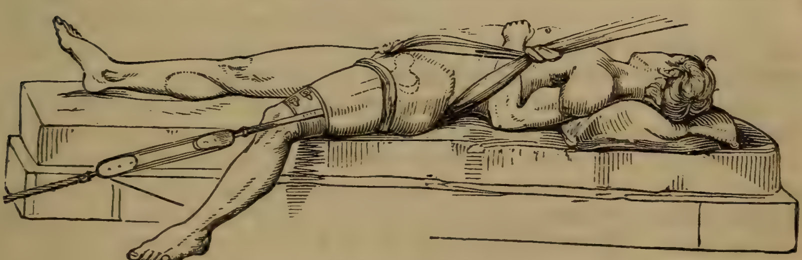
Pubic dislocation.

Fig. 502.

External appearances of pubic dislocation.

5. *Unusual Dislocations.*—The head of the femur has been observed to occupy a position between the anterior superior and the anterior

Fig. 503.



Mode of reducing pubic dislocation with pulleys.

inferior spinous processes, or in front or somewhat behind the latter. The symptoms are, shortening of the limb, the toes excessively everted, and the head of the bone can be felt in its abnormal position. The dislocation may be reduced by flexing the thigh, abducting and rotating it inwards, and finally bringing it down adducted; pressure upon the head of the bone with the fingers will contribute to a successful result.

It has also been seen displaced directly downwards; "the limb was lengthened three inches and a half, and was fixed and everted; the

trochanter was sunk; and the head of the bone close to and on a level with the tuberosity of the ischium, where it was capable of being moved under the fingers.

Three other anomalous forms of the dislocation have been recorded, viz., upon the body of the ischium between its tuberosity and spine, into the lesser sciatic notch, and forwards into the perineum.

In such cases the reduction may be effected by the flexion method, upon the principle already laid down for the other forms of luxations, due allowance being made for the differences in anatomical relations of the head of the femur.

Dislocation of the Patella.

The patella may be dislocated in four directions: outwards, inwards, upwards, and upon its own axis.

Dislocation—
1. Outwards.
2. Inwards.
3. Upwards.
4. Upon its own axis.

1. *Dislocation outwards.*—This is the most frequent variety, and may be incomplete or complete, the former being the most common.

In incomplete luxation the tissues about the joint are not damaged to any great extent; while in the complete variety the capsular ligament is torn through, and the ligamentum patellæ more or less lacerated; sometimes the other ligaments about the joint are also concerned in the injury.

Fig. 504.

Dislocation of the patella outwards.

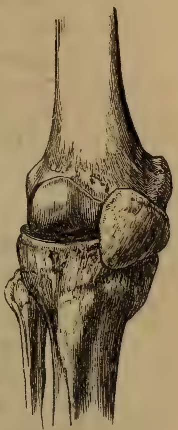
Causes.—The causes are external violence applied to the inner edge of the patella, and muscular action. It should be noticed that the inner margin of the patella is thicker than the outer, and much less protected by its corresponding condyle.

Symptoms.—The knee is more or less flexed and immovable; the inner margin of the patella can be felt inclining forwards and outwards when the dislocation is incomplete, or looking directly forwards when complete. In the latter position the vastus internus is put upon the stretch, which can be easily felt along the inner side of the thigh, while the ligament of the patella is drawn tense from below outwards, and forms a prominent ridge; a depression will be formed over the condyles from the absence of the patella; and the inner condyle is observed to project unnaturally.

Prognosis.—Usually the luxated bone can be replaced with ease and no unfavorable results follow; there are cases, however, where the parts never regain their wonted vigor; so that the patella is readily luxated again upon the application of slight force.

Treatment.—Place the patient upon his back, or, better still, let him sit in a chair; then extend the leg upon the thigh, and flex the thigh strongly upon the abdomen, so as to thoroughly relax the extensor quadriceps; then make pressure upon the outer border of the patella with the two thumbs, when it will resume its natural position.

Fig. 505.



Dislocation of the patella inwards.

When the reduction is effected keep the limb at rest for four or five weeks by means of a posterior splint bound to it with a roller bandage.

2. *Dislocation inwards.*—This injury is caused by blows upon the outer margin of the patella. Its symptoms will differ from those already noted in connection with outward dislocation only so far as they must necessarily be modified from the position of the patella upon the inner condyle. The treatment is the same.

3. *Dislocation upwards.*—It results from the excessive relaxation of the ligamentum patellæ; it has been seen to ascend the thigh as much as three inches. The treatment in such a case would be the application of one of the apparatus described in the article on fractured patella.

4. *Dislocation of the Patella upon its Axis.*—This is a very rare form of injury, and results from the same causes as the other varieties. The patella may occupy three distinct positions, according to the nature and direction of the force causing the dislocation: its inner border may repose upon the inter-condyloid space, with the outer border projecting forwards; or the reverse may occur, which is much more common; or the patella may be twisted completely around, so that its posterior face shall present anteriorly.

Symptoms.—The sharp margins of the patella can be felt in the median line of the joint, forming a ridge from which two planes slope outwards to the borders of the articulation, instead of the naturally rounded outline of this part; the limb is extended and immovable; and the patient suffers severe pain.

Treatment.—The same method of reduction may be tried in this case as in the first; if this should not succeed, as it will not sometimes, the leg should be forcibly flexed upon the thigh, and then extended, pressure being made at the same time upon the upper and lower margins of the patella in opposite directions.

Dislocation of the Tibia.

From the great size and strength of the knee-joint, dislocations of the tibia are uncommon, and, when they do occur, are generally incomplete. They are caused by violent blows upon the lower part of the thigh while the leg is firmly fixed; or by violence applied to the leg while the thigh is fixed; or, lastly, by violent rotation of the leg upon the thigh as an immovable centre, or the reverse.

DISLOCATION—

1. Backwards.
2. Forwards.
3. Inwards.
4. Outwards.
5. By Rotation.

1. *Dislocation backwards.*—This is the most common of these five varieties. If the luxation is complete, the posterior and crucial ligaments are lacerated, and the ligamentum patellæ and gastrocnemius muscle put upon the stretch, as well as the nerves and bloodvessels in the popliteal space; the head of the tibia is thrown back of the femoral condyles.

Fig. 506.

Dislocation of the head of the tibia backwards.

Symptoms.—If the dislocation is complete, the limb may be shortened a half or three-quarters of an inch, and it is usually in a position of extreme extension, though it may be straight or flexed; the head of the tibia projects strongly in the rear, while the condyles hang over the patella in front, causing a marked depression below them, across which the tendon of the extensor quadriceps is tensely stretched.

Prognosis.—When the injury to the joint is inconsiderable, and the dislocation has been promptly reduced, the patient usually makes a speedy recovery; on the other hand, there are cases in which months elapse before the functions of the limb are restored. In very severe injury to the articulation, excessive inflammation, with suppuration, sometimes follows, often requiring amputation or resection. A disposition to reluxation, and an inability to keep the leg straight in the erect posture, have also been noted as an occasional result of this dislocation.

Treatment.—The dislocation may be reduced by making extension and counter-extension from the ankle and thigh, or, better still, from the perineum, while the surgeon presses the bones in opposite directions to the displacement. Sometimes alternate flexion and extension, with slight rotation of the leg, will accomplish the object at once.

After-treatment.—The patient should be kept in his bed five or six weeks, with the limb in a straight position, and inflammatory action controlled by antiphlogistics; afterwards, gentle movements should be impressed upon the joint, to prevent anchylosis.

2. *Dislocation forwards.*—This differs from the preceding variety in the head of the tibia being thrown in front of the condyles, instead of behind, forming a prominence anteriorly, upon the top of which the patella reposes. The limb is shortened from one to four inches if the luxation is complete, and, viewed from behind, the leg appears unnaturally short, while a front view conveys the impression that the

thigh is lengthened. The movements are not so difficult as in the previous case.

The *treatment* is the same as in dislocation backwards.

Fig. 507.

Dislocation forwards.

Fig. 508.

Incomplete dislocation outwards.

3. *Dislocation outwards.*—This is almost always partial. Malgaigne has reported one case where the head of the tibia passed to the outside of the external condyle, and rose above the level of its articular surface.

Symptoms.—The limb presents a twisted appearance, and the leg is slightly flexed and rotated on its axis; the joint is increased in breadth, the tibia projecting externally, forming a tumor upon the outside of the articulation; the inner femoral condyle is equally prominent upon the inner aspect of the limb; and the patella is pushed outwards.

The *treatment* does not differ from that of posterior luxation.

4. *Dislocation inwards.*—This variety of dislocation is the reverse of the preceding; the head of the tibia is displaced inwards, so that the inner condyle of the femur rests upon the centre of its articulating surface. The symptoms and treatment will be the same as in luxation outwards, except so far as these must necessarily vary from the opposite position of the head of the tibia.

Fig. 509.

Incomplete dislocation inwards.

5. *Dislocation by Rotation.*—This injury occurs when the leg is twisted inwards or outwards so as to throw one of the femoral condyles from its articulating facet, while the other remains in its natural position.

Symptoms.—Rotation of the leg inwards or outwards, according as its inner or outer articular facet is displaced; it is slightly flexed; and the joint is altered in shape.

Treatment.—Extension and pressure upon the head of the tibia, with rotation of the leg in a direction opposite that of the displacement.

Dislocation of the Semilunar Cartilages.

Dislocation of the semilunar cartilages results from a sudden twisting of the knee-joint by striking the toes against an obstacle, or making a false step. One of the cartilages is thereby displaced, and, in some cases, may be almost entirely separated from its connection with the articular surface of the tibia, and become wedged between the joint-surfaces.

Symptoms.—The patient is aware that something has given way in the knee-joint, and he finds that he can neither support the weight of the body upon the limb nor fully extend the leg; he suffers severe pain in the knee, and feels sick and faint; and after the lapse of a few hours the articulation becomes swollen and tender.

Treatment.—The cartilage may be restored to its natural position by placing the patient upon his back, then raising the limb from the bed, let the surgeon support the ham upon his left arm, while he grasps the ankle in his left hand, and flexes the leg, rotating it at the same time outwards; then let him suddenly extend it.

Mr. Fergusson relates the case of a patient who could effect a replacement of the cartilage by pointing the toes outwards as much as possible, and then lifting the foot forward, with the opposite foot behind the tendo-Achillis; and Sir A. Cooper tells of a person who accomplished the same object by bending the thigh inwards, and drawing the foot outwards, while he sat upon the floor.

In order to support the joint, and thus prevent a renewal of the luxation, the patient should wear an elastic knee-cap.

Dislocation of the Fibula.

I. Dislocation of the Upper Extremity—
   1. Forwards.
   2. Backwards.

II. Lower Extremity—
   Backwards.

I. *Dislocation of the Upper Extremity of the Fibula.* 1. *Dislocation forwards.*—There are but three recorded examples of this dislocation, which results from muscular action, or direct force applied to the upper extremity of the fibula. It is recognized by the tumor caused by the displaced head of the bone, near the tubercle of the tibia; the tendon of the biceps flexor will be drawn forwards out of its normal situation; and marked depression will be observed below and upon the outer side of the knee.

In the treatment of this luxation pressure must be made upon the head of the fibula backwards to force it into its natural position.

2. *Dislocation backwards.*—This is caused in the same manner as forward luxation. In a case reported by Dubreuil the head of the fibula formed a tumor posteriorly; the foot was drawn outwards, and the whole outside of the limb was cold and numb.

The reduction was effected by flexing the leg moderately, and pressing upon the head of the fibula from behind forward.

II. Dislocation of the Lower Extremity of the Fibula. *Dislocation backwards.*—The only case of this variety of luxation is recorded by Nélaton. It was caused by the passage of a wheel over the upper part of the leg. The lower end of the fibula was forced backwards so as to be almost in contact with the tendo-Achillis; the outer face of the astragalus, uncovered by the external malleolus, could be distinctly felt; the foot was in a natural position. The patient presented himself at the hospital thirty days after the accident, and it was not deemed advisable to make any efforts at reduction.

Dislocation of the Foot (Astragalus upon the Tibia and Fibula).

The astragalus may be dislocated upon the bones of the leg in the direction indicated in the following table:—

Dislocation—

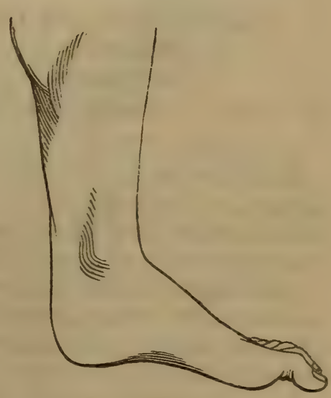
1. Forwards.
2. Backwards.
3. Inwards.
4. Outwards.
5. Upwards.
6. By Rotation.

1. *Dislocation forwards* (Fig. 510).—This is the most uncommon of the five varieties of luxation affecting the ankle-joint. It is caused by falls upon the heel while the foot is strongly flexed.

The ligaments about the articulation are ruptured, and the astragalus is forced forwards in front of the lower end of the tibia.

Fig. 510.

Fig. 511.



Dislocation of the foot forwards.

Symptoms.—The symptoms are: Lengthening of the foot in front of the malleoli, and a corresponding shortening of the heel, which forms, with the posterior surface of the leg, a straight line; the leg is

somewhat shorter than the other, and the malleoli approach nearer the sole of the foot and heel (Fig. 511).

Treatment.—For accomplishing the reduction, the patient should be placed upon the injured side, with the thigh raised perpendicular to the trunk, and the leg flexed at a right angle with the thigh, so that the muscles of the calf of the leg shall be relaxed. An assistant supports the thigh, and makes counter-extension, while the surgeon grasps the foot in his hands and draws it downwards; at the same time he endeavors to carry it backwards, in order to place the astragalus beneath the tibia.

The limb may be subsequently semiflexed, and placed upon a double-inclined plane, with a compress just above the heel.

2. *Dislocation backwards* (Fig. 512).—This dislocation is exactly the reverse of the preceding. It is caused by violent extension of the foot, as when its anterior part is firmly held while the body is thrown backwards. The lower extremity of the fibula is commonly broken, and the ligaments considerably lacerated. It may be complete or incomplete.

Fig. 512.

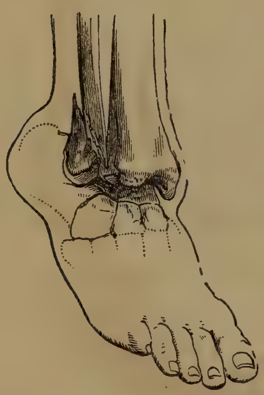
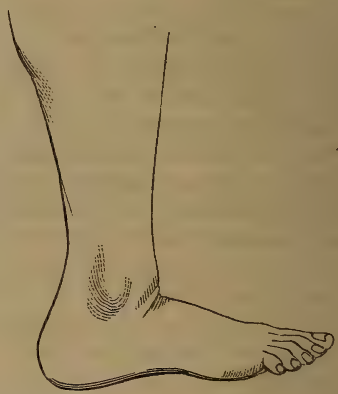


Fig. 513.



Dislocation of the foot backwards.

Symptoms.—The anterior part of the foot will be shortened, while the heel is elongated, and the tendo-Achillis prominent. The astragalus can be distinctly felt behind the ankle, and the end of the tibia in front of it; and the toes are depressed with a corresponding elevation of the heel (Fig. 513).

Treatment.—The reduction can be easily accomplished by extension in the manner directed for dislocation forwards; there is, however, greater difficulty encountered in maintaining it, as the bones have a constant disposition to slip from contact with each other.

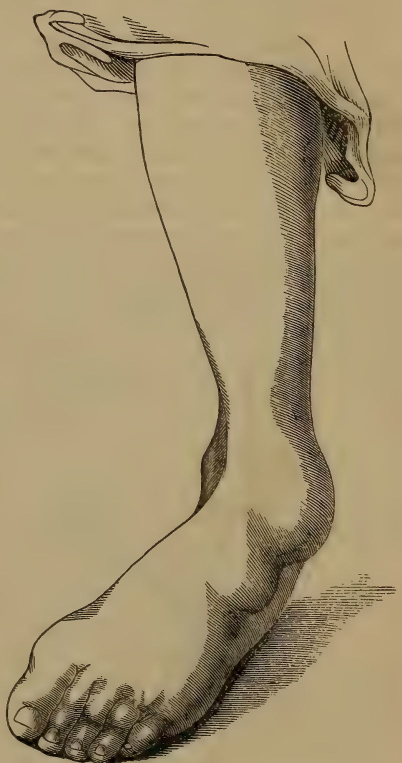
Dupuytren recommends that his splint for fractured fibula should be applied after the reduction, and the limb laid upon its side in a semiflexed position; and Malgaigne employed in one case successfully a boot-shaped splint of plaster of Paris.

Should there not be any contra-indication present, the starch

bandage applied to the foot and leg, would be serviceable; while in those cases where there is much swelling and inflammation, the leg may be placed in an ordinary fracture-box, with the foot secured to the footboard, the forward tendency of the tibia being overcome by compresses placed in front of, and above the ankle.

3. *Dislocation inwards* (Fig. 514).—In this luxation, the astragalus is either completely displaced inwards by slipping horizontally inwards from the articular surface of the tibia, or it rotates upon its axis so as to place its inner and upper margin against the middle portion of that surface in such a manner that its superior surface looks outwards.

Fig. 514.



Dislocation of the foot inwards.

The tibio-tarsal ligaments are usually ruptured, and the inner malleolus fractured; sometimes they are entire, and in that case the fibula will give way above the malleolus, the lower fragment remaining in connection with the tarsus; in other instances the tibio-tarsal ligaments will remain untorn, and both malleoli are fractured.

Causes.—Falls upon the foot, forcing it into an extreme degree of abduction; it is sometimes the result of direct violence, as the passage of a vehicle over the ankle.

Symptoms.—The foot is turned inwards, and the external malleolus forms a remarkable prominence upon the outer ankle; and the astragalus can be easily felt beneath the inner malleolus.

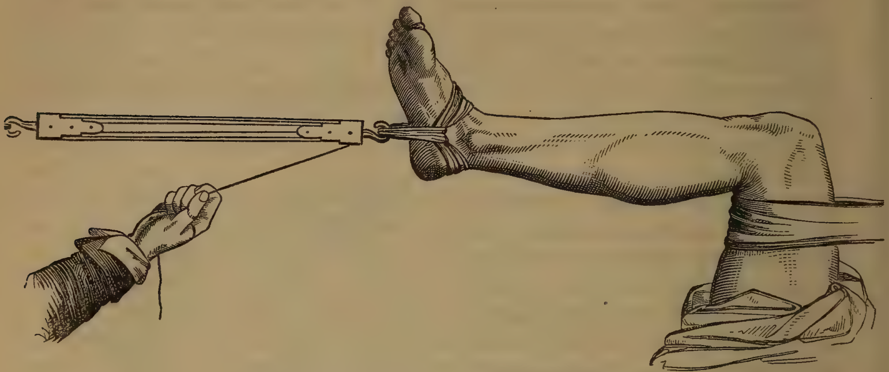
Prognosis.—This injury can only be produced by great force, which renders the prognosis always serious. It is often followed by severe inflammation and profuse suppuration, resulting in anchylosis.

Treatment.—The reduction is accomplished in the same general manner as previously described for luxation forward. The extension should first be made in the direction of the displacement, and when the astragalus begins to move in the axis of the leg, the surgeon at the same time abducts the foot, to throw the astragalus beneath the articulating surface of the tibia.

In both of the lateral dislocations it may be necessary to apply more force than can be effected with the hands, when recourse should be had to the pulleys in the manner shown in Fig. 515.

The *after-treatment* consists in applying two side-splints of gutta-percha, neatly moulded to the foot and ankle, so that these parts may

Fig. 515.

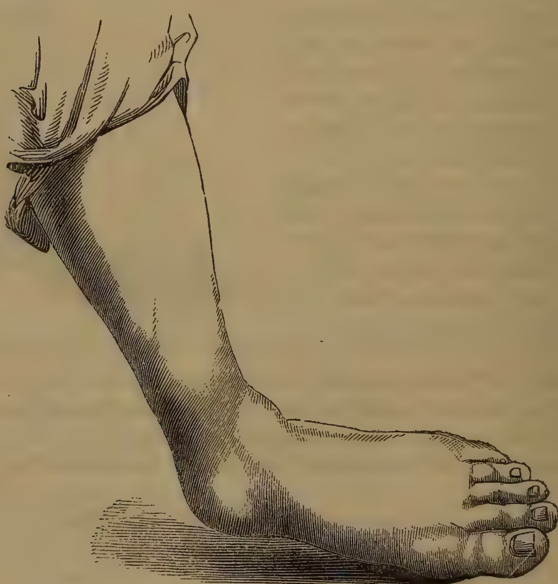


Reduction of dislocation of the foot with pulleys.

be thoroughly supported; the inflammatory action is to be combated by appropriate remedies.

If fracture of the fibula complicates the dislocation, the splint of Dupuytren should be employed.

Fig. 516.



Dislocation of the foot outwards.

4. *Dislocation outwards* (Fig. 516).—It is the most common luxation of the ankle; the astragalus rotates inwards, so that its outer and upper

border is in contact with the articular surface of the tibia, and its superior plane looks inwards. This peculiar position of the astragalus cannot be assumed without a rupture of the tibio-tarsal ligaments and a fracture of the fibula above the joint. There is also often found an oblique fracture upwards and outwards through the outer margin of the articular surface of the tibia.

Causes.—The causes of this luxation are falls upon the sole of the foot when it is somewhat abducted; and direct violence.

Symptoms.—The foot is abducted and the inner malleolus produces a protuberance beneath the skin upon the inner side of the foot; the inner margin of the foot rests upon the ground while its outer border is turned upwards; there is a depression above the outer malleolus over the seat of fracture where crepitus may be elicited; and the astragalus can be easily perceived beneath the external malleolus.

Treatment.—Extension should be made from the foot in the manner we have already pointed out; and when the reduction is effected Dupuytren's splint must be applied; or a gutta-percha splint, or a tin case, may be employed which shall perfectly sustain the foot and ankle. An important point in applying dressings in these dislocations is that in order that there may be no constriction of the parts by inflammatory swelling, the splints and bandages should, at first, be put on loosely.

5. *Dislocation upwards.*—The astragalus may be forced upwards between the tibia and fibula, the latter bone being in such a case always broken at its lower extremity.

Symptoms.—The symptoms are the following: The distance between the malleoli is increased, which gives the appearance of great breadth to the ankle; the inner malleolus projects nearly to a level with the sole of the foot, the opposite one being raised, sometimes as much as two or three inches; and the leg is shortened.

Causes.—A fall upon the sole of the foot in such a manner that the weight of the body is transmitted to the instep vertically.

Treatment.—The reduction is often difficult; it is effected by extension and counter-extension; the leg should then be placed in a fracture-box, and antiphlogistic remedies employed until the inflammation has subsided, when a pasteboard splint may be substituted for it.

6. *Dislocation by rotation.*—Huguier records a case where the foot was violently twisted outwards, while the leg was held firmly, so that the heel was nearly brought under the inner malleolus, and the toes rotated outwards through a half of a circle.

Treatment.—Extension and rotation of the foot inwards.

Dislocation of the Tarsus.

I. Astragalus.
   1. Forwards.
   2. Backwards.
   3. Inwards.
   4. Outwards.

II. Os Calcis and Scaphoid upon the Astragalus.
   1. Backwards.
   2. Inwards.
   3. Outwards.

III. Cuboid and Scaphoid upon the Os Calcis and Astragalus.
   Forwards and upwards.

IV. Scaphoid.
   Forwards.

V. Cuneiform Bones.
   Forwards.

1. *Dislocation of the Astragalus.*—This may occur forwards, backwards, outwards, and inwards, and it either retains its horizontal position, or may be more or less rotated upon its axis or even completely reversed, so that its inferior surface will look directly upwards.

a. Dislocation forwards is caused by a fall upon the foot in a position of extension; the astragalus is forced upon its dorsum, producing a marked prominence over which the skin will be tensely stretched; the leg is shortened, and the malleoli approximated nearer to the bottom of the foot.

Fig. 517.

Dislocation of the astragalus outwards.

b. Dislocation backwards is extremely rare; and is caused in the same manner as the preceding, only the foot is in forced flexion at the time of the application of the injury: the astragalus takes a position posterior to the joint under the tendo-Achillis, which is pushed backwards, and may be readily perceived in its new position; the instep is shortened, and the heel elongated.

c. Dislocations inwards and outwards (Fig. 517) are produced by the force acting upon the foot when it is abducted or adducted; they are mere varieties of the luxation forwards.

These injuries are often compound, and attended with more or less laceration and bruising of the soft tissues about the joint.

Treatment.—In simple dislocation of the astragalus, efforts should be made to effect its reduction. The patient should be thoroughly anæsthetized, and the thigh bent at right angles with the abdomen, and the leg upon the thigh; an assistant should then make counter-extension from the lower part of the thigh, while another takes hold of the heel and instep, or, what is better, applies an extending lac and firmly draws the foot downwards; the surgeon, standing by the limb, endeavors to press the astragalus upwards and backwards into its place with his thumbs or his knee; but if the bone has an inclination to either side, the pressure should be exercised first in such a manner

that the astragalus may assume the position it takes in forward dislocation. While the pressure is being made, the foot should be adducted or abducted, according as the one or other of these positions will permit the bone to slip back beneath the tibia. Should reduction be impossible, it is believed by the majority of surgeons that, in order to save the foot, the astragalus ought to be removed at once.

Fig. 518.

Compound dislocation of the astragalus inwards.

When there is a wound present, and the bone can be felt to be entirely separated from its articular connections (Fig. 518), it must be removed immediately, as it then acts, as any foreign body would, in causing inflammation and suppuration of the joint, which will lead most surely to amputation of the foot; this course is altogether the safest one, as in a number of the recorded cases in which the operation had been performed the patients recovered with tolerably good limbs. Nélaton's opinion is that in simple dislocation, even of the astragalus, the reduction ought not to be attempted, but immediate resection had recourse to. This view is in opposition to the practice of the majority of surgeons; and the instances of successful reduction on record are sufficiently numerous to induce the surgeon, in all cases of simple dislocation, to try manipulation before resorting to the knife.

The after-treatment consists in giving the leg and foot efficient support with splints, and to meet the inflammation with appropriate antiphlogistics: when suppuration begins, the pus should have a free issue exteriorly.

2. *Dislocation of the Os Calcis and Scaphoid upon the Astragalus.*—This dislocation may occur backwards, inwards, and outwards; the latter bone retaining its articular connections with the tibia. In dislocation backwards, the heel is elongated, and the foot in front of the malleoli correspondingly shortened; the head of the astragalus can be felt under the skin upon the top of the foot, lying upon the scaphoid and cuneiform bones.

The luxation inwards is marked by the prominence of the head of the astragalus upon the outer side of the instep; the foot is usually in a position of adduction, with its external border resting upon the ground, while the toes turn inwards and the heel outwards.

The astragalo-calcanean, peroneo-calcanean, and tibio-calcanean ligaments are more or less torn, and usually also the soft parts about the foot, particularly over the head of the astragalus, which may perforate the skin and be visible upon the side of the foot.

Dislocation outwards is the reverse of the preceding. The head of

the astragalus will form a prominence upon the inner border of the foot, which is forcibly abducted and sometimes greatly rotated upon the leg; when the os calcis is completely separated from the astragalus, it will be elevated by the side of the fibula, and the leg will be shortened. The injury is almost always compound, and the end of the fibula and head of the astragalus will often be found projecting through the wound upon the inner side of the foot.

Treatment.—The reduction should be attempted by making extension from the foot, and pressure upon the bones in a direction opposite the displacement; it is, however, often difficult, if not impossible, and may then demand either resection or amputation.

3. *Dislocation of the Cuboid and Scaphoid upon the Os Calcis and Astragalus.*—In the case recorded by Liston of this form of dislocation the cuboid and scaphoid were thrown upwards and forwards upon the os calcis and astragalus, caused by a heavy stone falling upon the foot, which was twisted in such a manner as to resemble club-foot. The reduction was effected by making extension from the forepart of the foot, and the patient was cured in five weeks.

4. *Dislocation of the Scaphoid.*—This has been observed to occur in several cases; the bone being detached from its connections with the cuneiform only, in one instance, and in the others from both the astragalus and cuneiform bones, and displaced forwards.

Treatment.—Pressure upon the scaphoid with the thumb, while the forepart of the foot is bent downwards.

5. *Dislocation of the Cuneiform Bones.*—The three cuneiform bones together may suffer in complete luxation forwards; or, what is more common, the internal cuneiform may be completely displaced, and thrown forwards and upwards upon the tarsus along with the metatarsal bones. The symptoms are foreshortening of the foot, the plantar surface of which is convex, both antero-posteriorly and transversely, and turned inwards; the proximal ends of the metatarsal bones form a ridge upon the top of the foot.

Treatment.—Extension from forepart of the foot with pressure upon the displaced bones.

Dislocation of the Metatarsal Bones.

The metatarsal bones may be dislocated separately in any direction by crushing force being brought to bear upon the foot; or all of them together may be thrown forwards and upwards upon the tarsus; the luxation in either case may be complete or incomplete. In the former case the foot will be shortened, and a ridge will be formed upon the top of the foot by the proximal extremities of the displaced bones; and the bottom of the foot will present a convex instead of the natural concave outline. When a single bone is displaced, its upper extremity will cause a recognizable deformity at the point of injury.

Treatment.—Extension from the forepart of the foot, and counter-extension from the lower portion of the leg above the ankle, combined with pressure upon the dislocated bones.

Dislocation of the Phalanges of the Toes.

Dislocation of the phalanges of the toes may occur in any direction, and be complete or incomplete. It is less common than that of the phalanges of the fingers, and more often compound.

The injury is caused by direct violence applied to the toes. Its treatment should be conducted upon the same principles laid down for dislocation of the phalanges of the fingers already explained.

PART V.

THE MINOR OPERATIONS OF SURGERY.

CHAPTER I.

RUBEFACTION.

Rubefaction, from *ruber*, "red," and *facio*, "I make," is the result of the action of that class of remedial agents called rubefacients, which have the property of causing redness, pain, and slight swelling of the skin.

The number of substances included in this class is quite large; besides, there are several mechanical processes that have been employed to obtain this modification of the integuments.

The rubefacients proper, when retained too long upon the surface, produce vesication; while the mechanical processes under ordinary circumstances determine rubefaction only; however, should the friction be violent, as occurs in the rapid passage of a rope through the clenched hand, for instance, true vesication follows; the same result may also accompany energetic shampooing.

All vesicants are necessarily rubefacients; and may often be used as such with advantage by simply regulating the period of their contact with the skin.

A peculiar mode of producing rubefaction for the cure of neuralgia, chronic rheumatism, and other painful and long-standing diseases has been in vogue in China and other eastern countries from time immemorial. The way I have seen it performed is this: The patient is stripped naked, and the operator, generally a barber, commences by striking the skin over the painful parts lightly with the tips of his fingers; and as it becomes accustomed to the new impression, and also somewhat numbed, the palms of the hands are substituted for the fingers, and the blows fall quicker and heavier, in regular rhythm, until the affected parts are quite red and tender.

The Hindoo operation of shampooing is also a very ancient counter-irritant process, and consists in the forcible pressure of the muscles with the hands, flagellations, and the crackings of the various joints.

The massage is sometimes of real utility in chronic affections of the joints, chronic rheumatism, false anchylosis, and sprains.

All these mechanical means will, however, be of limited utility, as possibly their only action is to blunt the sensibility of the skin by the repetitions of monotonous impressions upon the nerves; though the

counter-irritant effect of the determination of fluids to the parts, and the stimulation of the capillary circulation may add to their beneficial influence.

Of all the mechanical methods, friction is most frequently used in the treatment of surgical disease. It is of two kinds, dry and moist; the former being accomplished with the palms of the hands, coarse towels, or stiff brushes; and the latter with a piece of flannel, moistened with stimulating liquids.

This plan is indicated in the same class of cases as massage, care being taken that the continuity of the cuticle be not disturbed.

Rubefaction is most generally produced by the use of sinapisms, a name given to a pasty material composed principally of mustard, and spread upon cotton cloth for convenience of application.

Mustard, the flour of the seeds of the *Sinapis nigra,* depends for its rubefacient properties upon a volatile oil developed by the reaction between two of its constituents, myrosine and myronic acid, in the presence of water, the temperature of which, to obtain the most active cataplasm, should be inside of 212° Fahr.

Some persons are in the habit of employing vinegar instead of water, but the practice is wrong, as the former fluid materially interferes with the production of the volatile oil. Strong acids and the alkalies have the same effect.

If it is desirable to increase the activity of the mustard, red pepper, garlic, or cantharides in powder, may be added to it; on the other hand, to diminish its activity it may be incorporated with powdered flaxseed or bread crumb.

The time required for a sinapism to produce a rubefacient will depend upon the thickness and susceptibility of the skin, and the age of the patient. A thin skin with its nutritive processes going on actively, will show the effects of a rubefacient in a much shorter time than one in which the contrary conditions obtain, as in cases of paralysis, where several hours will elapse before any action is manifested, if it is manifested at all. It sometimes happens, however, in these paralytic patients that a sinapism may remain on for a long time; and when it is raised, no effect will be observed upon the skin, nor will the person complain of any pain or sensation in the part, yet at the end of some days vesication and even mortification may result.

As a general rule it may be stated that less time is required to produce rubefaction in children than in women, and in these than in men.

Under ordinary circumstances, sinapisms made with cool water should not be permitted to remain in contact with the skin longer than one hour, though in the special cases mentioned above a much longer or a much shorter period may be proper.

The best guide, in all cases, as to the proper time, where the nervous system is in its normal state, is the sensations of the patients; though the redness of the skin will be of some assistance, as it enables us to judge of the degree of rubefaction.

After the desired effect has been produced the sinapisms should be promptly removed, and the surface of the skin cleansed by allowing a little warm water to flow upon it. If there is much pain, a small

quantity of ether may be allowed to fall upon the parts, guttatim, which will assuage it immediately. Any soreness or tenderness will be best met by the application of lint dipped in glycerine, oil of sweet almonds, or olive oil. Ointments containing the ordinary narcotics, opium, belladonna, or stramonium will answer the same purpose.

When the continuous counter-irritant effects of a sinapism are required, it should be moved from point to point every few minutes to avoid too much action in one place, but yet not over too great an extent of surface; otherwise, unpleasant constitutional disturbance may ensue.

Under certain circumstances, it may be important to obtain rubefaction speedily; then the volatile oil of mustard dissolved in alcohol in the proportion of one part by weight of the former to twenty of the latter may be used, rubbing it upon the skin with a piece of flannel; its effects will be produced in three or four minutes. Other articles, as ammonia, will produce the same effects.

Urtication is a sort of rubefaction produced by striking the skin with a bunch of nettles (*Urtica dioitica*), or rubbing upon it an ointment containing the common cowhage (*Dolichos pruriens*).

In narcotic poisoning, flagellation with nettles was formerly employed; but its use is now entirely abandoned.

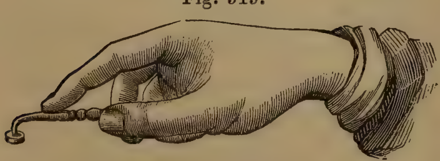
Sinapisms justly occupy a high position in the esteem of the people at large as a remedy of superior merit in numerous ailments, while the profession is equally as decided upon their virtues in numerous diseases coming daily under notice.

They are employed as a general excitant in syncopal attacks, shock, or severe concussion from injuries, and in nervous depression; as a local excitant to recall retrocedent eruptions and inflammations, as in measles, smallpox, gout, and rheumatism; as a counter-irritant in inflammatory diseases of the brain, and of the organs contained within the thorax and abdomen; and to relieve various painful affections from other sources.

Sinapisms form the favorite and safest counter-irritant in the diseases of children, when blisters are contra-indicated by the debility of the patient, or the extreme sensibility of the skin. We should be careful in these cases not to let them remain on the person of the child until constitutional disturbance results from the local stimulation, and thereby do more injury than can be counterbalanced by the good done by their counter-irritant effect.

For speedy rubefaction Dr. Corrigan recommends the instrument seen in Fig. 519. It consists of a thick iron-wire shank, about two inches long, inserted in a small wooden handle, having on its extremity, which is slightly curved, a disk or button of iron, a quarter of an inch thick, and half an inch in diameter.

Fig. 519.



Corrigan's button cautery.

To use the instrument, it is necessary to hold the button over the flame of a small spirit-lamp, keeping the forefinger of the

hand holding the instrument at the distance of about half an inch from the button. As soon as the finger feels uncomfortably hot, the instrument is ready for use; and the time required for heating it to this degree is only about a quarter of a minute. It is applied as quickly as possible, the skin being tipped successively at intervals of half an inch over the affected part as lightly and as rapidly as possible.

CHAPTER II.

VESICATION.

VESICATION, from *vesica*, a "bladder," or "blister," is the action of that class of remedies called vesicants, which cause inflammation of the skin, and an effusion of serum beneath the cuticle, forming little bladders or vesicles.

The local inflammatory action, with its accompanying derivative effects and constitutional excitation, does not constitute the whole therapeutical influence of vesicants; for along with this, there is an effusion of fibrinous serosity from the blood, which confers upon them an important value as depletants.

The extent to which this effusion sometimes takes place was shown in a case which came under my care some months since. The patient had an ordinary blister applied upon the abdomen, over night; and the following morning it was removed, displaying a large vesicle filled with a pale, yellowish, jelly-like mass, a quarter of an inch in thickness, which, with every movement of the patient, presented that tremulous motion peculiar to jellies. Its removal was followed, in a few hours, by another layer of the same material, though thinner, and it was some days before the serosity ceased to concrete spontaneously upon the blistered surface.

Some of the rubefacients already spoken of will vesicate if kept upon the surface a sufficient period, yet there are other articles more especially employed for this peculiar purpose, and they are drawn from all three of the kingdoms of nature.

Of the physical agents heat has been employed as a vesicant in several ways; yet it is not so readily manageable as to recommend itself as a general method; for though its action is speedy and certain, the fear of its causing an eschar, and the pain of its application, will restrict its use to a very limited number of cases.

A compress folded several times, then dipped into boiling water, and applied to the skin, will produce quick vesication.

The head of a hammer, or the flat cautery iron, held for a few moments in boiling water and laid upon the surface, will also give rise to the same result.

Sir Anthony Carlisle laid over the skin a wet cloth, and passed over it a flat cautery-iron, brought to a dull red heat.

It has been recommended in collapse, attended with great insensibility of the skin, to produce a blister immediately by placing a piece of tissue-paper, saturated with alcohol or spirits of turpentine upon the surface, and set fire to it. A jet of steam, from the spout of a vessel containing boiling water, has been suggested with a similar view.

We have already spoken, at page 69, of the liquor ammoniæ of the Pharmacopœia as a vesicant, and its mode of application. A watch-glass case will answer the same purpose as the lid of a box there mentioned. Place a round piece of muslin, a little smaller than the glass, and saturated with liquor ammonia, upon the skin, previously cleared of hair, and then cover it with the crystal. In half a minute or a minute a red areola will be seen to surround the margin of the glass, when it should be removed, and an appropriate dressing applied to the blister.

When the ammonia is incorporated with fatty matters, the vesicating ammoniacal ointment of Dr. Gondret is formed. "The amended formula is as follows: Take of lard 32 parts; oil of sweet almonds 2 parts; melt them together by the gentle heat of a candle or lamp, and pour the mixture into a bottle with a wide mouth. Then add 17 parts of solution of ammonia of 25°, and mix, with continued agitation, until the whole is cold. The ointment must be preserved in a bottle with a ground stopper, and kept in a cool place."—*U. S. D.*

This ointment is applied by spreading it upon muslin, and when freshly prepared it will vesicate in from five to ten minutes. The application will be more accurate, and the ammonia prevented from evaporating, by using a shallow pill-box lid instead of the muslin.

It will be a useful precaution, in using these ammoniacal mixtures, to protect the parts surrounding the place to be blistered, by adhesive plaster, which may be laid over them, having a hole of the proper size cut into it, to expose that portion of the skin to which the vesicant is to be applied.

The vegetable kingdom furnishes from the two orders, Ranunculaceæ and Euphorbiaceæ, many active vesicants, among which are several species of the Ranunculus, or crowfoot, which, before the introduction of the Spanish flies into use, were much employed as vesicants.

The knowledge of the powerful rubefacient and epispastic properties of these plants may, on occasions, be serviceable to the country practitioner. Nearly the same qualities are possessed by the bulb of the Indian turnip.

Mezereon-bark is also a slow vesicant, and is frequently used by German surgeons for this purpose. For the application of this, Chelius directs that "a piece of the bark an inch and a half long and the same wide should be soaked eight or ten hours in vinegar or water, after which it is to be applied with its smooth surface next to the skin, generally upon the arm, at the insertion of the deltoid muscle, and covered with a piece of oiled silk, compress, and roller, to keep it close. After ten or twelve hours, when the bandage is removed, if the skin be sufficiently inflamed, a piece of oiled silk is to be applied on the inflamed part and fastened with compress and bandage; but if

the first application have not been effective, a second piece of the bark must be applied. About the second or third day a new piece of bark is put on, the skin rises, and a serous fluid exudes. The part must be cleansed daily with warm water or milk; and if the inflammation be very great, it must be rubbed with warm milk and bound up with some mild ointment."

Croton oil, obtained by expression of the seeds of the Croton tiglium, is an excellent vesicant. Its operation is not at all painful, nor actively depletive, but mildly counter-irritant. For these reasons it recommends itself highly to the notice of the practitioner in those cases of disease where long-continued counter-irritation has been found useful. The oil may be applied to a large extent of surface, without any fear from constitutional disturbance or of its manifesting its specific action upon the intestines.

It may be used pure, or diluted in various degrees with olive oil, and rubbed into the skin with a piece of flannel, or the point of the finger protected with oiled silk.

Two or three applications will be necessary to obtain the desired result, which consists in the production of a crop of vesicles, at first containing a clear fluid, but in a little while this becomes opaque and yellowish. The skin beneath the vesicles is changed to a red color, accompanied with a sensation of stinging and swelling of the parts.

After two or three days the pustules dry up, the irritation disappears, and new cuticle is formed.

The application of the oil in this manner requires two days or more to produce the effect, in consequence of the escape of crotonic acid, upon which its efficacy depends. To avoid this, Bouchardat suggested to M. Chomel a formula containing one part of the oil incorporated with four parts of lead plaster, spread upon linen in the same manner as adhesive plaster. These proportions may, however, be varied according to circumstances. This plaster, worn upon the person twenty-four hours, will produce an abundant eruption of vesicles.

In employing preparations containing croton oil, care should be taken that the patient's hands do not come in contact with the parts, else some of the oil will be transferred to the skin of the eyelids, scrotum, or other localities, and thus produce swelling of them, and an annoying sensation of burning.

The application of a dressing of glycerine or cold water will relieve these unpleasant accidents.

The animal kingdom supplies from among the coleopterous insects several vesicating species, of which only two—the cantharis vesicatoria, or Spanish fly, and the cantharis vittata, or potato-fly—have been introduced into the Pharmacopœia of the United States, and it is of these that our officinal preparations are made.

The cerate of Spanish flies (*Ceratum cantharidis*) is the common blistering plaster of the shops; it should be spread upon leather, though linen, or even paper, will answer the purpose when that is not to be had. In applying the plaster, the skin is to be cleansed of hairs and well rubbed with vinegar or oil, which will materially facilitate the action of the vesicant. It is recommended that the surface of the

blister be covered with oil or a layer of simple cerate, oiled paper, or, what is better, a piece of very thin tissue-paper or gauze. These interposed substances will prevent the particles of the flies sticking to the skin and producing strangury. With the same view, the late Dr. Joseph Hartshorne was in the habit, in cases where he apprehended such a result, of directing four grains of opium and twenty of camphor to be mixed with the cerate of a blister of large size; an ethereal solution of camphor may also be used, brushed over the surface of the plaster before it is applied.

The decoction of the uva ursi, in the dose of a wineglassful every hour during the application of the epispastic, is also highly recommended as a preventive of strangury.

The time the blister should be kept on depends upon the object had in view, the general sensibility and age of the patient. If simple vesication is desired, or what the French call a "flying blister," the cerate should remain on a shorter time than if a permanent one is required, or one destined to be kept open a long time; in very susceptible subjects, and particularly in children, great care is necessary that the irritation do not extend too far, as mortification of the integuments has happened in such patients. The safest plan in these cases is to keep the plaster on only until the skin is bright red, when a poultice must be applied, which will raise a vesicle in a few hours.

The average time for the retention of a blister upon the skin in an adult may be stated to be four hours; the skin of the scalp being much thicker than it is in other localities, will require a longer time for the plaster to vesicate—from twenty to twenty-four hours.

The mode of dressing the blistered surface depends also upon the object had in view by the practitioner; if it is not intended to keep up a discharge, the vesicle must be punctured with a lancet, or the points of the scissors, and the serum permitted to escape, when it may be dressed with a cerated cloth, an emollient poultice, or, what is more common in domestic practice, with a cabbage leaf; in two or three days the irritation will have subsided; and in four or six more the surface will be healed. Dr. Maclagan recommends a dressing of raw cotton after the serum is evacuated, which is to be renewed as often as it becomes soaked, care being taken not to pull off the cuticle in the operation. If a permanent blister is required, after the evacuation of the serum, the cuticle is to be removed, and a dressing of basilicon ointment, or some other stimulating substance is to be applied to the raw surface, which will prevent its healing, and increase its secretion.

It has been suggested, when the patient is comatose, to tear the cuticle off suddenly, so that the sudden impression of the air upon the delicate nervous loops of the surface below may produce a salutary shock to the nervous system, tending to rouse the dormant energies.

Another mode of using the cantharides is under the form of cantharidal collodion, prepared by dissolving gun-cotton in an ethereal solution of cantharidin, the active principle of Spanish flies. It possesses the advantages over the cerate of keeping a long time without change, and of being more prompt in its action; it should be applied to the surface, prepared as in the former case, with a camel's hair

brush, and covered with a piece of oiled silk. Cantharidin is also incorporated with wax, and spread in a very thin layer upon fine waxed cloth, silk or paper, constituting the blistering cloth, blistering paper, vesicating taffetas, etc. of the shops.

When there is too much irritation of the blistered surface, and false membrane is formed upon it, great advantage will accrue from the use of emollient poultices; while severe pain may be controlled by employing the watery solution of opium, applied by a piece of soft old linen. Care should be taken that the suppurative action be not continued so long as to give rise to the formation of a thick and knotty cicatrix. If the discharge becomes profuse and fetid, poultices containing Labarraque's solution, finely-powdered charcoal, or creasote may be laid upon the part.

When it is desired to stop the drain, an ointment consisting of equal parts of simple cerate and the cerate of the subacetate of lead will be found the most efficient application for this purpose.

Blisters are sometimes produced for other purposes than counter-irritation, as when, from any cause, as the excessive irritability of the stomach, etc., medicines cannot be swallowed, their introduction into the system may be effected by simply placing them upon the denuded cutis, constituting what has been called the endermic method of medication.

In this way morphia, quinine, and other remedies may be employed; they should be finely levigated or powdered, so as to contain no grittiness to irritate the surface; and, if too active, may be incorporated with some fatty or gelatinous matter. It is always better, when it can be accomplished, to simply make an aperture in the vesicle, and slip the medicine into it, so that the air may not come in contact with the cutis, which diminishes its absorbent power; or to raise the cuticle, and, after sprinkling the powder upon the cutis, lay it down again.

Should the remedies act energetically upon the system, their absorption may be arrested by making compression upon the blistered surface.

CHAPTER III.

CAUTERIZATION.

CAUTERIZATION is the process by which the vitality of the tissues is destroyed by heat or certain chemical agents, the former being called the *actual* cautery, and the latter *potential* cauteries. They act by decomposing the tissues, and thereby destroying the life of the part; the new combination produced, generally dark-colored, and technically named the *eschar*, now becomes foreign matter, and is ultimately separated from the living tissues beneath by inflammatory action.

1. *Actual cauterization* may be produced by several methods, which we shall consider *seriatim*.

The red-hot iron was much employed by the ancients as a cautery,

and highly lauded by Hippocrates. It continued to be used freely in numerous surgical diseases for centuries. In later times, Pouteau, Dupuytren, and the elder Larrey were its warm admirers, but at present surgeons have very much restricted the limits of its application.

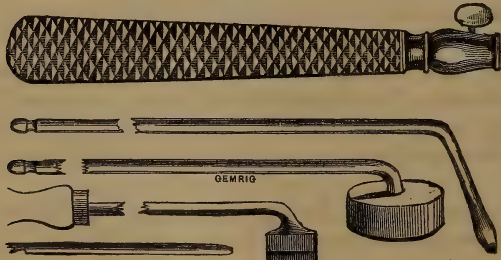
The effects of the actual cautery upon the body are: the production of moderate pain, and a black eschar at the point of its application, which is subsequently thrown off, leaving a suppurating surface beneath; there is also a decided impression made upon the nervous system not observed to follow potential cauterization, whose influence is more local. The supervening inflammation produces a local derivation and a general excitation, which latter may amount to fever if not checked by appropriate measures. It is important to remember that if the cauterization is only intended to destroy the tissues, the local inflammation ought to be restricted at once, if possible, to that degree necessary to throw off the eschar; on the contrary, if a powerful derivative effect is desired, as in ulceration of the cartilages, for instance, Pott's disease, and coxalgia, the inflammation should be permitted to progress within safe limits; and hence it is, that repeated touching of the issue with the hot iron, when the inflammation decreases, is so much more beneficial and effective, in these cases, by renewing the counter-irritative action, than any other sort of application for this purpose.

The wound remaining after the separation of the eschar heals up rapidly, though a cicatrix of a size proportioned to the extent of the slough always remains.

The ancients employed irons of various shapes and made of different metals, upon the supposition that the action of the latter was dissimilar; but as heat is the efficient agent, it matters very little of what metal the cautery is made; though iron, or, better still, steel, is the material now used; steel changes color with the different degrees of temperature, so that the surgeon is enabled very well to decide by color alone how far the metal is heated.

The cautery is provided with a wooden handle, to which irons of different shapes may be attached by means of a socket and thumb-screw; these various forms are very well shown in the annexed wood-cut (Fig. 520). The conical cautery is convenient for cauterizing in

Fig. 520.



Different forms of the cautery.

cavities, as the neck of the uterus, the walls of the vagina being protected by a speculum previously introduced; the narrow pointed iron

will enable the surgeon to reach the mouth of the bleeding vessel at the bottom of a wound; and in obstinate hemorrhage from a stump which had resisted all other means, I employed this cautery with success. The nummular cautery having a broad surface is used to make issues, while the one with a hatchet-shaped extremity furnishes a form by which the cauterization may be restricted to narrow lines.

Should the proper cautery iron not be at hand, an iron rod, or spike of proper size, will answer well enough.

The pain of the actual cautery will depend in a great measure upon the degree of heat of the iron, a white heat being much less painful than if the iron be heated to redness only. In forming a thick eschar, it is advisable to re-apply the iron brought to a white heat, for five or six seconds each time, rather than let it cool in contact with the tissues; for then it sticks to the part, and, if forcibly withdrawn, may bring the slough with it, and thus, perhaps, renew a hemorrhage it was designed to check.

The point at which the cautery is to be applied must be wiped dry, that the heat may not be absorbed in converting the secretions into steam; and care should be taken also that the cauterization be not performed over the tracks of large bloodvessels and nerves. If it should be necessary to protect the adjacent parts, a cloth wrung out of cold water may be laid upon them; or, in narrow passages and fistulous canals, a metallic tube, or one prepared with an ordinary visiting card, will secure their walls from contact with the iron.

A common hammer dipped in boiling water and kept in contact with the skin ten or twelve seconds will produce an eschar, and has been recommended as a general excitant in suspended animation from prolonged immersion in water, and from poisoning by prussic acid and its compounds. Cloths wrung out of boiling water have been employed in the same manner; they will produce an eschar in from eight to ten minutes.

Various combustible bodies have been used as cauterizing agents, such as phosphorus in small grains laid upon the skin and then set fire to. The pain produced is intense, and the contact of the phosphoric acid formed with the wound causes an almost intolerable burning sensation. Camphor and gunpowder have had their advocates, but this method of cauterization is now properly abandoned.

The actual cautery may be employed with advantage as a hæmostatic in sealing up the mouths of bleeding vessels in wounds or operations in persons laboring under the hemorrhagic diathesis; to check hemorrhage following the extraction of teeth; to arrest the progress of caries; as a counter-irritant in chronic articular affections and ulceration of the cartilages in angular curvature of the spine; and in coxalgia.

The galvanic cautery was first proposed by M. Heider, of Vienna, in 1844, and afterwards tried in France by Sédillot, Amussât, and Nélaton, without, however, deriving the advantages claimed for it by its advocates. In 1854, M. Middeldorpff, believing that the difficulty in the way of its practical use resulted from the want of a proper battery and suitable instruments, brought it prominently into notice

again with improved appliances which rendered the application of the cautery convenient and effective; and since that time it has been used by surgeons generally with more or less success in the treatment of those diseases in which the actual cautery is indicated.

M. Middeldorpff employs a Groves' battery of four couples, to each pole of which a conductor is atttached two yards long, and composed of eight copper wires wrapped in silk (Fig. 521); the distal extremities of the two conductors are connected with the tip of the ivory handle of the cautery by thumb-screws (A A) making a connection in this manner with two insulated wires, E, which run through the handle and terminate beyond it in two sockets furnished with two thumb-screws, F F, to receive the different forms of the cauteries; upon the side of the handle there is a little button (B) by pressing upon which the connection is instantly broken, and the electric current ceases to flow through the wires.

Fig. 521.

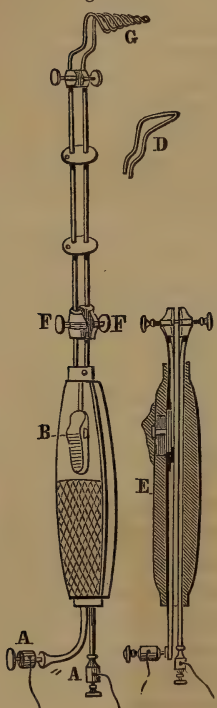


Fig. 522.

Fig. 523.

Galvanic cauteries.

The armatures of the ivory or ebony handle are variously formed; the olive-shaped and nummular cauteries consist of a platinum wire wrapped spirally around grooved, thin, and hollow porcelain shells, which are rendered incandescent by the heat of the wire; they are intended for the cauterization of some extent of surface, as in making issues, destroying the tissue about the neck of the uterus, &c. (Figs. 522, 523.)

The hatchet-shaped and conical cauteries are formed of narrow strips of platinum bent upon themselves in different ways.

Galvanic setons are formed of platinum wires of different sizes, which are drawn through fistulous canals, or the tissues we propose to cauterize by straight or curved needles. Mr. Marshall, of London, who has paid a good deal of attention to this subject, devised the instrument seen in the annexed wood-cut (Fig. 524), for cauterizing the interior of serous or fungous granulations.

The galvanic porte-ligature (Fig. 525, 5) is formed of a platinum

wire passing through two short metallic tubes borne upon a handle, in such a manner as to form a loop, which is placed around the base of

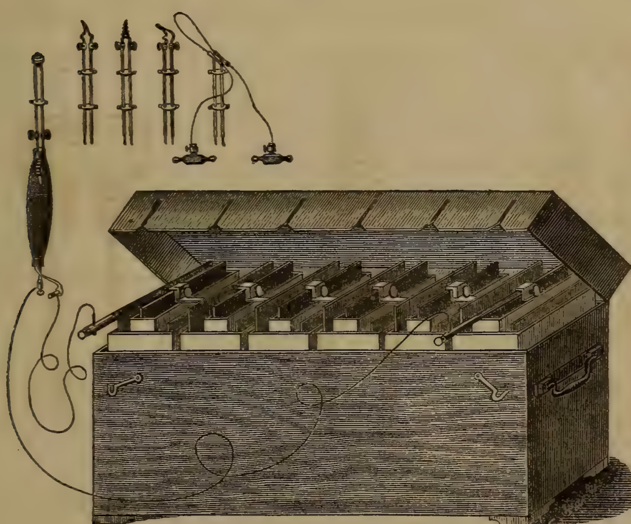
Fig. 524.

Marshall's galvanic seton.

the part to be divided, and drawn tight by two handles attached to the extremities of the wire; this instrument cuts the tissues perfectly.

M. Rumkorff has substituted for Groves' battery employed by Middeldorpff that of Bunsen, seen in the adjoining illustration (Fig.

Fig. 525.



Bunsen's battery with the cauteries attached.

525). With this apparatus, composed of six elements, the desired amount of heat can be readily obtained. Figs. 1, 2, 3, 4, and 5 show the variously shaped cauteries described above.

In applying these cauteries, they are to be placed in contact with the part cold; and then the galvanic current may be established and continued sufficiently long to obtain the object in view; ordinarily, from five to fifteen minutes will suffice to procure moderate cauterization.

2. *Potential cauterization* is produced by various chemical agents, each possessing some peculiarity in its mode of action or degree of activity and manageability. That a caustic may act properly, a certain amount of moisture is required; if there is too much, the liquid will flow over the adjacent surface, or combining with the caustic will

form a protecting layer between it and the parts beneath; and hence it is necessary, in open wounds, sores, &c., where the secretion is abundant, to cleanse them of the pus, with pellets of lint before applying the caustic.

The thickness of the eschar produced by a caustic will depend upon the nature of the substance used, and the length of time it is kept in contact with the skin. The milder articles, called catheretics, produce thin, light-colored eschars, which quickly separate from the parts below; the stronger ones form thick, black sloughs, which require a much longer period to become detached (sometimes a month or even more), depending upon the amount of inflammation produced.

When the caustic has produced the effect desired, the part should be thoroughly cleansed of all excess of the material employed; this may be accomplished with vinegar, if the caustic is alkaline, or with a solution of carbonate of soda, if it should be acid.

The greatest watchfulness will be required during the application of those caustics capable of being absorbed, and producing poisonous effects, such as the bichloride and the acid nitrate of mercury and arsenic, all of which have produced death in this manner. As a rule, these articles should not be spread over a large extent of surface, or applied upon freshly-made or bleeding wounds. Bérard has never seen any bad results follow the application of the bichloride of mercury after the hardened borders of the sore had been removed with the knife, and the caustic put on after the suppuration was established.

The fused nitrate of silver is the caustic most frequently used by surgeons; it produces, when applied to wounds, a thin white eschar, which separates in a day or two; upon the skin the eschar is brownish or of a deep violet color.

The stick of nitrate of silver, brought to a point, is employed to cauterize ulcers of the cornea, in inflammatory affections of the conjunctiva and eyelids, in poisoned wounds, to arrest hemorrhage from leech-bites and small vessels, to suppress exuberant granulations, and to abort the pustules of variola, &c.

Sulphate of copper is also a mild caustic or catheretic of great value in the treatment of inflammatory diseases of the conjunctiva, granular lids, &c. It is prepared for use by selecting a fine large crystal of the sulphate, and chipping one of its extremities to a smooth point, that the conjunctiva may not be injured by its roughness.

Caustic potassa (potassa fusa) may be used alone, but it is more commonly mixed with lime, forming the Vienna plaster. Its action is very limited, so that it rarely extends to the subcutaneous cellular tissue, whatever the quantity of the article applied.

The eschar is blackish, and separates in a few days.

Caustic potassa is sometimes had recourse to for making issues, and opening abscesses, both superficial and deeply seated. It is applied in the following manner: A piece of adhesive plaster has a perforation made in it, and is then laid over the part to be cauterized; upon this a fragment of the caustic, the size of a pea, is placed, and a second piece of adhesive plaster confines the whole. After this dressing is removed, a poultice is applied until the eschar comes away, or the

latter may be incised with a knife. This plan has been pursued in opening abscesses of the liver, where the object is to produce sufficient inflammation to agglutinate the layers of the peritoneum together before issue is given to the pus, otherwise a fatal peritonitis would be likely to follow.

It may also be used to cauterize poisoned wounds, but for this purpose it is much inferior to the liquid caustics, which more readily penetrate in every direction into pockets and crevices where some lurking portion of the poison might escape the solid caustic.

The Vienna paste is prepared with fifty parts of caustic potassa to sixty parts of quicklime; the materials are to be thoroughly pulverized before being mixed, and then made into a paste with a small quantity of alcohol; the eschar formed is black, and comes away in eight or ten days.

This caustic may be made in a more convenient form by melting the potassa in an iron pot, and then adding slowly the quicklime, stirring the while with an iron rod until the materials are thoroughly mixed, when they may be poured into cylindrical moulds of sheet-lead.

In applying the Vienna paste, a layer two lines thick, and of the exact size of the eschar required, is laid upon the part; in five or six minutes the skin will be cauterized to the cellular tissue, which is known by the appearance of a gray line on the margins of the paste; the caustic should then be removed with any dilute acid. If deeper cauterization be required, fifteen or twenty minutes will be necessary.

Arsenious acid forms the active ingredient of several cauterizing powders and pastes which have enjoyed much reputation for their efficacy in destroying cancerous and other morbid growths; among these may be mentioned, as the best known, the powders of Rousselot and of Dupuytren, and the paste of Manec.

Rousselot's caustic may be prepared by mixing sixteen parts each of the red sulphuret of mercury and dragon's blood, with eight parts of white oxide of arsenic; before being applied, the powder must be made into a paste with a little gum-water.

Manec's paste is composed of fifteen grains of arsenious acid, seventy-five of the red sulphuret of mercury, and thirty-five of burnt sponge.

A layer of either of these preparations, from one to two lines thick, may be spread upon the sore, and covered with lint, over which a bandage is placed. The eschar is made in a few days, and is thrown off between the tenth and twentieth, bringing with it the caustic paste; the surface beneath, after one application, will generally present a healthy appearance, though it may be necessary to apply it again and again before all the diseased tissues are destroyed.

Swelling of the face, and œdema of the eyelids follow its application to the face, but these subside in three or four days without any further accident.

These caustics are most frequently employed in the treatment of lupus and some cancroid diseases.

The paste of the chloride of zinc (Canquoin's caustic) is composed of chloride of zinc and flour, which, absorbing moisture from the

atmosphere, becomes converted into an elastic mass, that may be readily applied to the surface.

Canquoin employed pastes of three different strengths, the first containing one part of the chloride of zinc to two of flour, the second, one part to three; and the third, one part to four.

The caustic does not spread, and acts cleanly to a depth proportional to the thickness of the paste employed.

The acid nitrate of mercury is also an active escharotic, but requires care in its management; no large absorbing surface should be cauterized with this fluid, as it may produce excessive ptyalism, violent colics, diarrhœa, etc., and its use has in a few cases resulted in death. The part to which it is applied must be well cleansed, and freed from moisture; the caustic may then be applied with a brush, or a piece of lint mounted upon a wooden stem. It has been principally used to cauterize chancres and ulcerations about the neck of the uterus.

Cauterizing pastes may also be prepared with the concentrated mineral acids, with tow, sawdust, asbestos, or saffron; but they are not near so manageable as Manec's or Canquoin's caustics.

Malgaigne prefers the caustic recommended by M. Récamier to the acid nitrate of mercury. It consists of a solution of the chloride of gold in nitro-chlorohydric acid, and cauterizes deeply, while the eschar formed by it separates in three or four days. It gives but little pain, and its action is purely local.

Dr. Simpson thinks highly of a paste made of the sulphate of zinc, with glycerine or lard in the proportion of an ounce of the sulphate to a drachm of glycerine, or two drachms of lard.

M. Maisonneuve reported a plan of cauterization to the Academy of Medicine, in Paris, in 1848, differing from that usually pursued, in that the caustic is made to act from the interior of the parts to be destroyed to their surface.

For this purpose he selected the caustic of Canquoin already mentioned, from the fact that it can be easily moulded into any desired shape, possesses no toxic effects, and is a powerful hemostatic.

The paste is rolled into a circular cake, and cut into wedge-shaped

Fig. 526.

Maisonneuve's plan of circular cauterization by wedge-shaped pieces of caustic.

Fig. 527.

Maisonneuve's plan of parallel cauterization by lancet-shaped pieces of caustic.

Fig. 528.

Mode of cauterizing small tumors with a spindle-shaped piece of caustic.

pieces of an appropriate size by lines extending from the centre to its circumference; when dry the pieces are ready for use, and are then thrust into the midst of the morbid growth through little incisions made at equal distances around its base, as seen in Fig. 526.

In other cases, where the tumor cannot be circumscribed in this manner, the pieces of caustic may be made lancet-shaped, and lodged in the tumor in a parallel direction, as seen in Fig. 527.

This process succeeds well in those regions where the morbid tissue lies deeply among other parts; as in the axilla, neck, groin, vagina, and rectum. Small tumors may be attacked by a single spindle-shaped piece of caustic thrust to its centre, through an incision made with the bistoury, as shown in Fig. 528.

Mr. Paget, of London, has employed in certain cases lancet-shaped pieces of wood dipped in fused chloride of zinc.

CHAPTER IV.

MOXA.

THE moxa is a combustible substance, which is burnt slowly upon the skin, usually producing an eschar. It has been used by the orientals in medicine for centuries; they prepared it from the dried leaves of the Artemisia moxa, a species of the mugwort, which were beaten and formed into the shape of small cones. Many other articles have been used for the same purpose as the pith of the greater sunflower (*Helianthus aureus*), punk, cotton, and paper rendered more combustible by soaking it in a solution of the nitrate or chlorate of potassa. A convenient moxa may be made of raw cotton, moderately compressed, and wrapped with silk or cotton-cloth, so as to form a cylinder an inch long by one to two inches in diameter; this may be stuck to the part, where the counter-irritation is to be established, with a little gum, or held in contact with it by a little instrument designed for the purpose, consisting of a handle supporting a ring, in which the moxa is secured by two pins passing through it, and the minute holes perforating the circumference of the ring; the moxa is then set on fire and kept in a uniform state of combustion by a stream of air driven from a small blow-pipe, or, more simply, from the mouth alone.

Fig. 529.

Porte-moxa.

To protect the surrounding parts, a wet cloth should be laid over them; or, what is better, a card with a hole cut in it.

The combustion should be allowed to go on slowly in order to produce the greatest amount of counter-irritant effect, and an eschar of sufficient thickness, if the latter is desired. Where a more moderate

action is required, a piece of thick cloth, wetted with water, may be interposed between the skin and the moxa.

The skin is at first reddened, and the patient experiences a pleasant sensation of warmth, which, as the fire approaches the surface, is converted into a decided pain; the skin crackles as its moisture is dissipated, and is finally converted into a fissured black eschar, while the parts just around it are reddened and vesicated.

The eschar separates in from ten to fifteen days, leaving a sore which readily heals.

The first dressing should be a simple bit of adhesive plaster, laid over the cicatrized surface; and when pus begins to ooze from beneath its edges it may be replaced with the simple dressing. If the resulting inflammation is too severe, it should be controlled with water-dressings.

The moxa should not, as a rule, be employed over the course of large vessels or nerves, nor upon bony prominences.

Moxibustion is employed to produce revulsion in caries and other chronic diseases of the bones, in obstinate neuralgias, and chronic inflammations.

CHAPTER V.

ISSUE.

An issue is a counter-irritative, suppurative discharge established in the subcutaneous cellular tissue. It is not so prompt in its action as the rubefacients and vesicants, but is more permanent in its effects, and more exhaustive.

The issue may be made at almost any point, taking care always to avoid osseous and muscular eminences, and the courses of the large bloodvessels and nerves. It is usual to select some part where the issue would be exempt from any interference in consequence of muscular movements; from the rubbing of the clothes against it, &c.; and at the same time permit the convenient application of the necessary dressings.

In local diseases it will generally be desirable to place the issue over the suffering organ, or as near to it as possible.

The point of selection, in affections of the head, is the back of the neck. Velpeau prefers the triangular space bounded above by the occiput, at the sides by the splenic muscles, and having its apex at the spinous process of the axis; his reason is, that in this spot there is a thick bed of cellular tissue and muscle in direct vascular connection with the internal parts, and in proximity with large and important nerves. Others recommend that it be placed lower down, so that it may be concealed by the dress. In the arm, the space be-

tween the deltoid and biceps, near the insertion of the former muscle, will be found most eligible.

An issue for the lower extremity is generally established at the depression upon the inner side of the thigh, about two or three inches above the inner condyle, just over the vastus internus; though in this situation the dressings are not so easily maintained, both from the conicity of the thigh and the disturbing influences of locomotion. The points above mentioned are the most desirable for the establishment of a permanent issue. For temporary counter-irritation, while the patient is confined to bed, any part above the suffering organ, with the exception we have made above, may be chosen—in diseases of the lungs, the depressions beneath the clavicles; in those of the abdomen, over the liver, duodenum and iliac fossa, according to the situation of the organ. In affections of the spine, any portion of the vertebral grooves will answer for the seat of the issue—alongside of any particular vertebra that may be diseased.

Issues are made in several ways; the first and most valuable is with the actual cautery. The iron should be heated to whiteness, and applied quickly to the part, and as quickly removed before it has time to cool. The eschar formed is black, and generally separates in five or six days. Water-dressings should be employed until this occurs, and the surface kept discharging by the application of some stimulating ointment or foreign body; or, what is better, by passing the heated iron slightly over the surface as occasion requires.

When the iron is white hot, there is no great pain produced, for the obvious reason that the nerves of the part are instantly deprived of their vitality.

The potential cautery is also employed for the same purpose. In using the potassa fusa it should be remembered that the eschar will be twice as large as the fragment of caustic, from its great tendency to spread; its mode of application has already been described at page 582. At the end of five or six hours, or when the pain ceases, the dressings should be removed and the part examined; in the centre of a circle of inflammation will be found the black and dead integument, forming an eschar, which it is now the object to get rid of; a poultice may be applied repeatedly, which will bring away more or less of the slough at every dressing; in this manner in from ten to twenty days it will be completely removed.

Irritating ointment or peas are then applied to keep the sore discharging.

Some have recommended the eschar to be cut across, a pea put in the incision and confined with a bandage: as the issue progresses the eschar softens, turns gray, and finally drops off, leaving a clean granulating surface beneath, which must be kept discharging by peas, glass beads, or other irritants, to which a thread may be attached to facilitate their removal when it becomes necessary.

The Vienna paste is preferable to the potassa fusa in making an issue, inasmuch as it does not spread upon the surrounding tissues, in consequence of the lime it contains restraining the fluidity of the caustic potassa, while at the same time it renders this more active by

seizing any carbonic acid that may be present in it. The eschar formed is of a pale drab color, and separates in seven or eight days.

The caustic is applied in the same manner as the potassa fusa, and permitted to remain in contact with the skin ten or fifteen minutes, when it is removed by washing the part in some dilute acid; a poultice is then applied.

Blisters have been used to make an issue, but the process is inefficient and painful; the blister simply destroys the cuticle, and the peas have to be bound on so that they may penetrate the cutis by ulceration; in this manner the discharge of pus will, of course, be delayed, and its quantity be small until this result is obtained.

Dr. Golding Bird has recommended the following plan to procure a clean, healthy granulating surface with a free discharge of pus: Apply two small blisters within a few inches of each other, and after the vesicles are formed discharge the serum; over the blister intended for the issue place a zinc plate, and upon the other one a silver plate, then connect the two together with a copper wire. In forty-eight hours a decided eschar will be formed under the zinc plate, and suppuration will be established in four or five days, when the apparatus must be removed and a poultice applied; the skin beneath the silver plate will be found entirely healed.

The explanation of the action of the apparatus is that the galvanic current decomposes the chloride of sodium of the serum, evolving chlorine at the positive, or zinc pole, which, seizing hold of that metal, forms the chloride of zinc, the well-known escharotic.

The quickest and least painful manner of forming an issue is with the knife; but it is inferior to the other plans in its immediate revulsive action, as the irritation of a clean cut bears no comparison with the slow destructive effects of the caustics or the violent impression of the actual cautery.

This method is better adapted to the scalp than to any other region, and has been pursued in certain affections of the meningeal membranes. The incision should be from a half to an inch in length, proportional to the size of the issue; and rather than make a long incision, a crucial one should be preferred through the skin and cellular tissue; in this incision place some foreign body, as a garden pea, a small piece of gentian or orrisroot, a grain of corn, a small pebble, or a glass bead, which will produce the suppurative action in three or four days. Should this be delayed, the foreign body may be spread with some stimulating ointment, mezereon, for instance. After the suppuration is once established, a simple dressing once a day will generally suffice to insure cleanliness. If the granulations become fungous, they should be repressed with the nitrate of silver; severe inflammation must be met with water-dressings, poultices, &c.

An issue may be readily healed by withdrawing the irritating body from it, and substituting a simple dressing.

CHAPTER VI.

SETON.

The seton, from *seta*, a "bristle," is made by passing a strip of some material beneath a narrow tongue of the skin and cellular tissue, to establish a secretion of pus. The name is applied both to the wound made and to the material put into it.

Occasionally the seton is used with other views than as an exutory, as when a thread or cord is introduced into the tunica vaginalis, or between the ends of a broken bone. Here the object is, in the first case, to excite the adhesive inflammation, and in the second, to cause an effusion of reparative material. It has also been placed in cavities, to facilitate the escape of a foreign body, as in old gunshot wounds where the projectile has not yet escaped; but for this purpose it is now obsolete.

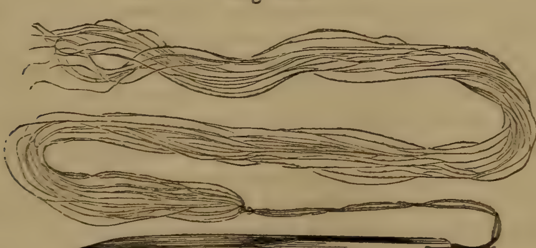
Again, where there is a constriction of some duct of the secreting glands, the seton is had recourse to, to dilate it; as in fistula lachrymalis, and in Stenon's duct in salivary fistula.

As an exutory, setons are now generally applied to the neck about the height of the fourth or fifth cervical vertebra, and to the inner sides of the extremities; they have also been used upon the chest and abdomen, and, in obstinate disease of the uterus and bladder, over the pubis.

In very irritable subjects this mode of counter-irritation is extremely painful, and will often have to be abandoned for some other method, more especially if inflammation and suppuration of the cellular tissue to a considerable extent follow, as they sometimes do; in these cases the little tongue of skin usually sloughs, leaving an open wound.

The operation is simple, and may be performed with the seton-needle, or with an eye-probe and bistoury. The seton-needle, as seen

Fig. 530.



Seton-needle armed.

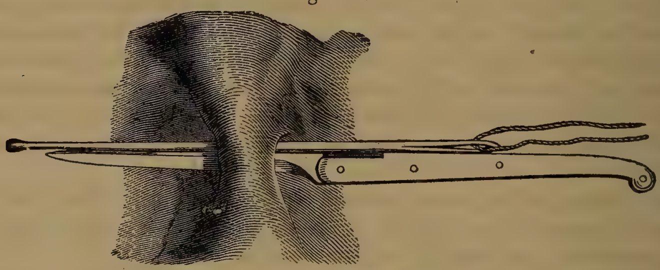
in Fig. 530, is a flat, lance-shaped instrument, four or five inches long, by six lines broad, with a large eye at its heel, to carry the thread or

tape. It is used by raising a fold of the integuments between the fingers, and thrusting the needle through its base, when the point of the needle is seized and the threads drawn into their place.

The second method, with the bistoury and probe (Fig. 531), is better, as these instruments are always at hand, and, in drawing the seton into the wound, the fingers will not slip from the probe, as they do from the needle covered with blood and resisted by the elasticity of the tissues.

A fold of skin is raised with the thumb and three fingers of the left hand; the bistoury, held in the right, with the edge downwards, is passed through its base, giving the point of the knife a little inclination downwards, so that one of the parallel incisions may be a little longer than the other, in order to facilitate the escape of pus; the probe, armed with the seton, is now passed beneath the skin upon the

Fig. 531.



Mode of introducing a seton.

back of the blade of the bistoury, when the latter is to be withdrawn, while the seton is pulled into the position it is destined to occupy. A little blood escapes from the wound at first, but soon ceases, and in three or four days suppuration is established.

The material of which a seton is made is a skein of cotton, a narrow piece of cotton cloth, or, what is better yet, a thin slip of India-rubber. This is to be drawn beneath the skin a little way at each dressing; and when it is exhausted, before the last remnant is removed, a new slip should be loosely tacked to its end, to be pulled into the wound in its turn. If a strip of India-rubber is employed, it does not need renewing, but may be simply sponged clean.

The long end of the seton should be on the side of the shortest incision, so that it may not be soiled by the pus.

As to the dressing, a poultice may be applied until the suppurative action is established, and then a simple dressing, or a perforated compress smeared with cerate, may be laid on the wound and covered with a little charpie, the whole being secured by the circular bandage of the neck. This dressing need not be disturbed for three or four days, and after the wound begins to suppurate it should be dressed every day; if the discharge is very abundant, twice daily, the soiled part of the seton being removed with the scissors.

Should the suppurative action be tardy, a little ointment of basilicon or cantharides may be put on the seton.

This mode of making counter-irritation is far inferior to that by the issue, being less cleanly and efficient.

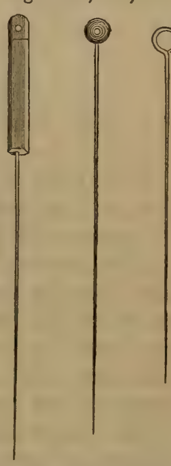
CHAPTER VII.

ACUPUNCTURE AND ELECTRO-PUNCTURE.

1. ACUPUNCTURE consists in the introduction of metallic needles into the tissues of the body. It is an extremely simple operation, the needles passing between the fibres without dividing them or shedding blood.

The method was introduced into Europe by the Dutch surgeon, Then-Ryne, who had resided on the island of Desima, at Nangasaki, in Japan, and there learned the plan. It is of the highest antiquity, according to the Oriental physicians, and I have seen it generally practised by the native surgeons both in China and Japan. The needles used may be made of gold, silver, platinum, or steel; they should be slender, sharp, and well polished, in order to penetrate the tissues without difficulty. A small steel handle, with a ring at one end and a socket at the other, to receive the needles, completes the instrument either for acupuncture or electro-puncture. In employing the needle, it may be seized in the hand, and plunged, at one stab, to the required depth into the painful part, or driven in by a quick, smart blow with a ruler. I prefer, however, to rotate the needle between the thumb and index finger, making gentle pressure all the time until the point of the needle is put in the position required.

Figs. 532, 533, 534.



Acupuncture needles.

The operation has been practised upon almost every part of the body, but it will be prudent to avoid thrusting the needle into the splanchnic cavities and large bloodvessels; with these exceptions, the instrument may be shoved boldly into any part of the body to a depth of one, two, or three inches, as circumstances may direct.

The number of needles that will be required in any case will vary from three or four to twelve; I introduced twenty in an obstinate case of sciatica with advantage. They may be permitted to remain in for a few minutes—or, as is generally done, two or three hours; there will be no objection to extending the time to two or three days.

To remove the needle, press the skin at the point of puncture with the tips of the fore and middle fingers of the left hand, and draw the handle towards you with the right.

Usually a little blush of redness will surround the puncture, and perhaps a slight numbness will be present; though in certain cases patients have been known to suffer extreme pain during the operation and after the needle has been removed. In a few instances,

where the needles have not been properly tempered, they have been broken by the strong muscular contractions excited by them.

Acupuncture has been recommended in the treatment of neuralgia, sciatica, angina pectoris, paralysis, chronic rheumatism, and chronic gout. Recently it has been used in aneurism, anasarca, hydrocele, and varicocele. I know of two cases of hydrocele radically cured by the persevering use of the needles. Carrero has employed it also in cases of asphyxia from drowning, and other causes, by thrusting the needles into the heart and diaphragm.

2. Electro-puncture is performed after the needles have been introduced as above directed, by attaching to the rings of the steel handles the poles of a galvanic battery, and sending a current of electricity through the tissues intervening between the needles. If it is desirable to communicate a shock, the Leyden jar, charged with electricity, may be used. During the passage of the current the patient feels more or less pain, and an unpleasant contraction of the muscles, which cease with the interruption of the current. Over the electrized part little blisters and boils sometimes form.

Electro-puncture has been used in the same kind of cases as acupuncture.

CHAPTER VIII.

PUNCTURING.

Puncturing is the operation of thrusting an instrument either sharp at its point only, or also cutting upon its edges, into the tissues or cavities, natural or morbid, of the body.

The simplest form of a puncture consists in making little wounds into the skin or mucous membrane with a needle, to evacuate infiltrated fluids beneath them. This operation may be performed upon any part of the body, as the scrotum and legs in dropsical effusions; the instrument required is a needle, or a very slender-pointed bistoury, which should be thrust perpendicularly through the skin, and withdrawn in the same direction without enlarging the wound; the fibres are simply separated, and no loss of substance or cicatrix follows.

Great care should be taken in puncturing the skin in œdematous leg, as it becomes very thin by the pressure of the effused fluids, and impaired in its nutritive activity. Instrumental interference has sometimes caused an erysipelatous inflammation, resulting in gangrene.

Scarification differs from puncturing in that the point of the lancet or bistoury penetrates the tissues more deeply, and divides the fibres of the parts; in fact it consists in making little incisions.

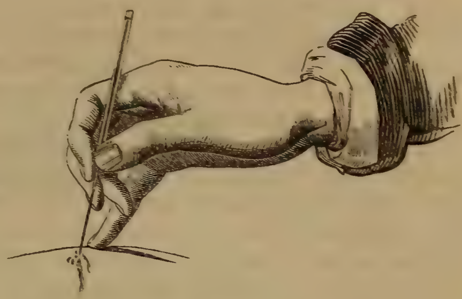
The operation can be performed either with the lancet, scalpel, or scarificator.

It is employed in phlegmonous erysipelas to favor the escape of pus, in chemosis, in sanguineous congestions of the tongue and tonsils, and in œdema of the glottis.

For the purpose of evacuating the fluid accumulated in morbid or the natural cavities, the lancet, bistoury, or trocar is used.

In opening abscesses, the bistoury is, perhaps, the best instrument; it should be held in the manner shown in Fig. 535, when the hand is steadied with the little finger, while the instrument is pushed forward by the movements of the thumb, index, and middle fingers. The puncture should be made generally at the thinnest part of the swelling, and in a line parallel with its long axis, should no special reason require it to be done otherwise.

Fig. 535.



Manner of holding the bistoury in opening abscesses.

Mr. Fergusson deems the attitude seen in Fig. 536 best suited to cases where pus is deep-seated, and when, probably, the surgeon has misgivings as to its presence at all.

The forefinger of the left hand is placed over the abscess with gentle pressure; the back of the knife rests against the side of the finger while the tissues are divided to the desired extent.

Should "Syme's abscess lancet" be employed, the best position for holding it to prevent its point suddenly plunging into the abscess is that seen in Fig. 537, in which the hand is steadied and supported with the little finger.

Fig. 536.

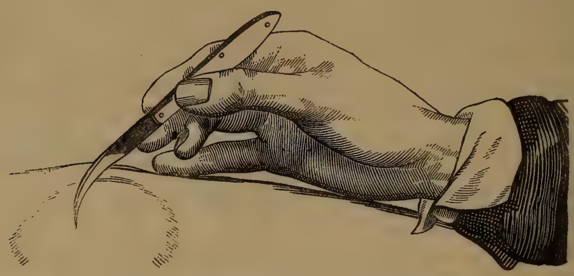
Manner of holding the bistoury in opening deep-seated abscesses.

In puncturing the chest and abdomen, an instrument called the trocar (Fig. 538) is used; it is a cylindrical metallic stem fitted to a large bulbous handle, and terminating in a sharp point with three cutting edges; fitting over this stem there is a movable tube, resting against the handle by its funnel-shaped expansion, and reaching within a quarter of an inch of the point of the stem, which it should clasp closely, that there may be no jutting shoulder to impede its progress through the tissues.

In using this instrument, it is held in the palm of the right hand by the last three fingers and the thumb resting against the junction of the stem with the handle, while the index finger is extended along

the canula to graduate the depth to which the point is to be plunged; it is then to be thrust into the cavity quickly and the trocar removed,

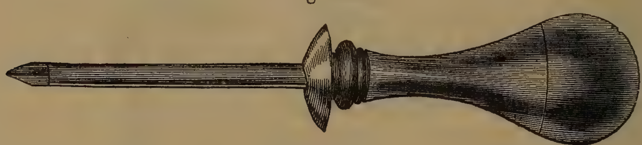
Fig. 537.



Mode of holding "Syme's abscess lancet."

leaving the canula in the wound. When the cavity is large, as the fluid escapes its walls collapse, and the canula will be displaced if the operator does not support it with his fingers; the position of the point of the canula may also be changed occasionally to facilitate the escape of the fluid.

Fig. 538.



The trocar.

Valvular puncture differs from the foregoing only in the skin being shifted a little to one side before the puncture is made, so that after the fluid escapes, and the instrument is withdrawn, the internal and external orifices do not correspond when the parts again resume their normal relation.

CHAPTER IX.

VACCINATION.

Vaccination is a process which consists in inserting the vaccine virus beneath the cuticle, so that it may come in contact with the absorbents.

This little operation can be performed at any point of the surface, though the place of election should always be the arm, and in infants the arm farthest from the nurse in the position they are usually carried.

The virus is effective in persons of all ages, though it is always prudent to perform the operation, when there is any choice left, at the age of three or four months.

Some persons bring the virus in contact with the absorbents by simply scratching the cuticle from the cutis with the point of a lancet; some make three or four little incisions into the skin at right angles to each other; others again form little pockets by pushing the point of the lancet obliquely between the epidermis and true skin a distance of the one-sixteenth of an inch.

Some physicians prefer an instrument specially constructed for vaccination; it resembles the ordinary lancet somewhat, though smaller, and has a slight groove upon one side of the point of the blade to receive the virus which is obtained from the vaccine vesicle between the sixth and tenth day of its appearance, when it should be limpid; or, as is more commonly done, a small piece of the scab is powdered and mixed with water.

When the operation is terminated, the arm is left exposed to the air for some time, until the blood dries upon the surface to protect the vaccine matter in the punctures; a loose circular bandage of soft linen may then be applied to prevent the chafing of the arm.

About the end of the third day, after a successful vaccination, the skin a little way around the puncture becomes hard and a little red; on the fifth or sixth day the areola increases in size, and an effusion takes place beneath the cuticle, forming a vesicle of a roundish form and of a silvery or pearly color; the vesicle is depressed at its centre, or umbilicated; and continues to increase in size to the eighth day, when the fluid is limpid and transparent and contained in a number of little cells; on the ninth day the vesicle becomes darker at its centre, which has ceased to present the umbilicated appearance, and becomes flattened; the areola surrounding it has gradually increased in size, become of a vivid red color, and occasionally presenting a number of transparent vesicles. On the tenth day, the swelling and heat in the part have considerably increased, restraining the free motion of the arm; the glands in the axilla are swollen and tender. At this time the patient experiences some little febrile excitement, and occasionally there is an erythematous blush over other parts of the body. On the eleventh day, the fluid in the vesicle becomes purulent and the areola commences to fade, and the general symptoms, if they have been present, diminish in intensity; or disappear if they have been slight. The desiccation of the vesicle proceeds from the centre to the circumference until it is converted into a brownish circular scab which deepens in color to a brownish black in a few days, and diminishes in size; the inflamed areola has decreased apace with the desiccation of the vesicle until the twentieth day, when the crust falls off, leaving a depressed cicatrix of a circular contour with little pits upon its surface. As it is not always convenient or even possible to transfer the vaccine virus from one arm to another (though it is evidently the most efficient way), it is important that proper care should be taken to preserve the "scabs;" and in collecting these, that the subjects from whom they are obtained

shall present palpable evidence of exemption from any scrofulous or venereal taint, chronic skin diseases, and general debility.

The crusts may be preserved for a long time by wrapping them in alternating layers of yellow or white wax and tin-foil. I vaccinated a patient successfully with matter thus protected nearly two years old.

To collect the lymph from a vesicle, the best plan, according to MM. Bretonneau and Fiard, is to use capillary glass tubes, which, after the fluid has been drawn into them, are to be hermetically sealed by holding their extremities for a moment in the flame of a spirit lamp.

Another plan consists in receiving the virus from the vesicle upon a glass plate, to which it will adhere; another glass plate is now laid over the first, and their edges joined together with wax or by pasting paper around them.

Jenner soaked up the fluid with threads; the vaccine virus is in this method always exposed to the air, and is soon destroyed.

The lymph may also be received upon ivory, pearl, or horn slips shaped like the blade of a lancet, and sharp enough to enable the surgeon to thrust their points beneath the skin.

To preserve the matter for a few hours the point of a lancet will answer; but after this time the metal quickly oxidizes and destroys the virus.

Should an unusual amount of inflammatory action take place around the vesicle, a soft linen rag wrung out of hot water may be laid on the parts; or a solution of the subacetate of lead, taking care not to rub the crust off the arm.

Vaccinia having run the ordinary course described above, the patient is generally preserved the balance of his life from smallpox—I say, *generally*, for instances are recorded where smallpox has attacked patients after successful vaccination.

CHAPTER X.

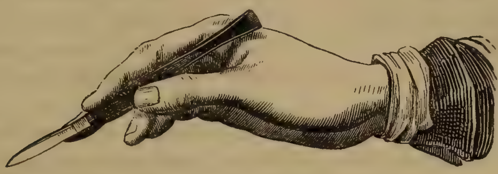
INCISIONS.

Incisions are solutions of continuity of the soft tissues made with cutting instruments. They are so constantly employed in various manners by the surgeon in the routine of practice as to constitute a large portion of operative surgery; hardly a surgical procedure can be accomplished without involving to a greater or less extent the division of the tissues. They often constitute in themselves little operations, as the opening of abscesses, scarifications, punctures, &c. The larger operations, as amputations, ablations of tumors, &c., are nothing more than simple incisions variously modified to suit the exigencies of particular cases.

Incisions are practised with a variety of instruments, but those principally used are scalpels, bistouries, and the scissors.

Certain rules have been laid down by some distinguished surgeons to govern the manner of holding the knife; and although most persons will hold the instrument as best suits their convenience and the attainment of the object they have in view, yet it will be well for the young surgeon to learn early those positions which have been found by experience to be the most convenient and graceful in making the various incisions required in operating.

Fig. 539.



Scalpel held as a pen.

In Fig. 539 the scalpel is held as a pen, with its edge downwards; the index-finger and thumb supporting it at the junction of the blade with the handle; the middle finger is a little in advance of the index, upon the side of the blade; the ring and little fingers are free, and, resting upon the skin, serve to support the hand. This position is convenient in making punctures and short incisions; in those of greater length, the hand may be drawn along the surface, still steadied by the ring and little fingers, or the latter may be raised from the skin so as to give it the greatest latitude of motion. The pressure upon the knife must be proportioned to the depth it is necessary to carry the incision, the resistance of the tissues, and the proximity of important parts.

This position may sometimes be advantageously modified by turning the edge of the blade upwards, as in cutting upon a director from within outwards, opening abscesses, &c.; or, again, by drawing the blade beneath the palm of the hand, with its edge either turned up or down, according as the operator desires to cut towards or from himself.

In Fig. 540 is shown a method in which the thumb is placed upon the articulation of the blade with the handle, and the fingers upon the

Fig. 540.

Scalpel held as a violin-bow.

opposite side; it permits the freest movements of the knife, and is adapted to rapid and extensive incisions. The cutting edges can be directed, according to circumstances, upwards and downwards, or to either side.

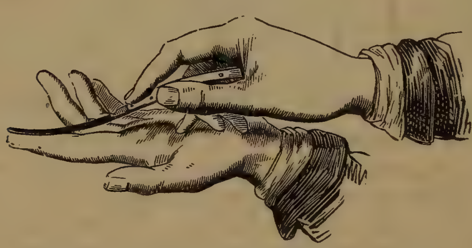
A very elegant position, in which the hand has the most perfect control over the knife, is seen in Fig. 541. The handle is held in the palm of the hand by the ring and little fingers, the thumb and middle finger being placed near the articulation, while the index is extended along the back of the blade.

Fig. 541.

Bistoury held as a carving-knife.

There are several modes, also, of making incisions either from within outwards, or the reverse; upon a director, or without one; and in certain cases, where the part to be divided is some distance below the surface, and cannot be seen, the point of the finger may be used as a director upon which the point of the knife may be guided, and at the same time prevented from damaging the surrounding organs; this method is sometimes employed in dividing constricting bridles, as in relieving strangulated hernia. (Fig. 542.)

Fig. 542.



Manner of using bistoury with the finger as a director.

The direction of incisions will vary in each case, according to the objects the surgeon desires to obtain, and it may, therefore, run from right to left, from left to right, towards the operator, or in the contrary direction. As a general rule, it will be desirable, if possible, to make incisions in the same direction as the muscular fibres, large bloodvessels, and nerves; so that in the extremities they would be longitudinal, oblique over the pectoral and abdominal muscles, and parallel with the natural folds in the palms of the hands, groins, and soles of the feet, and with the branches of the facial nerve upon the face.

In making an incision with the knife, in order to avoid the partial division of the skin at the extremities of the incision, and thereby forming what are technically called "tails," the instrument should be introduced perpendicular to the surface, then brought down to a less angle with it, and drawn along to the desired extent; when the handle is to be again elevated, and the blade withdrawn perpendicularly.

That the incision may be neat, it will be necessary to stretch, or at least to support, the integuments while the scalpel is cutting through the tissues. This may be done with the outer border of the left hand and thumb placed in a parallel position upon each side of the incision, and exercising gentle traction in opposite directions; or the part may be grasped in the left hand at a point opposite the incision, and with the fingers and thumb moderately tighten the skin; this plan is adapted to those portions of the body, such as the testicles, and the smaller sections of the limbs, that the surgeon can encircle with his hand. The same purpose may be also accomplished by making the incision between the left index and middle fingers laid parallel upon the surface.

Simple incisions are those made with one stroke of the scalpel, and are those most frequently used; they may either be straight or curved, as seen in Figs. 543 and 544; both of them are made in the manner already described; in the curved incision the convexity may be directed towards any point that may be deemed best to secure the object in view.

Fig. 543.

Straight incision.

Fig. 544.

Curved incision.

Compound incisions are those formed by the meeting of two or more simple ones, and receive the names of the letters which they resemble. Those most frequently used are seen in Figs. 545, 546, 547, and 548.

Fig. 545.

V-shaped incision.

Fig. 546.

H-shaped incision.

Fig. 547.

L-shaped incision.

Fig. 548.

T-shaped incision.

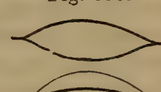
In making these incisions, the second simple incision should always terminate in the first, and not begin from it; and, that the blood may not conceal the place where the second incision is to be located, the first and lower one ought to be made first. Their object is to expose the parts beneath the integuments more fully than could be effected with simple incisions. They form flaps of greater or less size, according to their extent, which are dissected from the deeper tissues and raised up; thus affording an opportunity to the surgeon to gain free access to and remove morbid structures, however deeply placed they may be.

A large extent of surface of deeply-seated parts may also be exposed by the crucial incision seen in Fig. 549, which consists of two simple incisions crossing each other at right angles.

Fig. 549.

Crucial incision.

Fig. 550.



Elliptical and semilunar incisions.

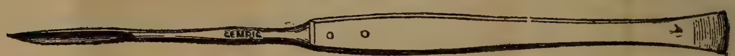
In many cases of large tumors it becomes necessary to remove a portion of the integuments entirely, so that the resulting flaps may just cover the parts beneath; this is accomplished by an elliptical incision such as is seen in Fig. 550; it is formed by joining two curved incisions at their extremities. The semilunar incision may be also used for the same purpose as the

elliptical, but it is now rarely employed; it consists of two concentric curved incisions, joined together at their ends, as seen in Fig. 550.

There are surgeons who prefer the scissors for making certain incisions; Malgaigne always chooses them when the parts may be divided at one stroke.

Subcutaneous incisions are now frequently had recourse to for the purpose of shielding the parts divided from contact with the atmosphere while the reparative process is going on, which experience has shown will occur without inflammation. The instrument employed for this operation is seen in Fig. 551. It consists of a narrow blade

Fig. 551.



Knife for subcutaneous incisions.

with a long, slender stem connecting it with the handle. In using the knife, the blade is introduced flatwise beneath the skin, obliquely, under the part to be divided, when its edge is directed against it, and by a slow sawing motion the section is effected. The instrument is then withdrawn, and the little wound hermetically sealed, either with a small piece of adhesive plaster, or a bit of charpie soaked in blood or collodion.

CHAPTER XI.

BLOODLETTING.

Bloodletting is an operation performed for the purpose of diminishing the quantity of blood in the system, with a view of relieving or curing diseases.

It may be drawn from the arteries, veins, or capillaries; in the first two instances the bleeding is said to be *general*, and in the latter, *local*.

The former plan, now almost abandoned, is had recourse to when the amount of blood to be drawn is large, and a decided effect is to be made upon the system; and the latter, when the object is rather to deplete a certain organ or part, without reference to the system at large.

There are cases, however, where both methods may be employed together with advantage.

SECTION I.

GENERAL BLEEDING.

Venesection, or Phlebotomy.—In former times bleeding was performed upon most of the large veins, the operation in each particular case being supposed to possess some peculiar advantages; but

at present the physician, knowing that the general character of the effects of loss of blood is the same whether a vein be opened in the arm, in the neck, or in the leg, selects the most convenient place for the operation, and general experience has decided that to be the bend of the elbow. Here the veins are moderately large, superficial, and easily dilatable by a bandage placed upon the arm.

By reference to the annexed wood-cut, Figs. 552 and 553, showing the veins of the bend of the elbow, it will be seen that there are five

Fig. 552.

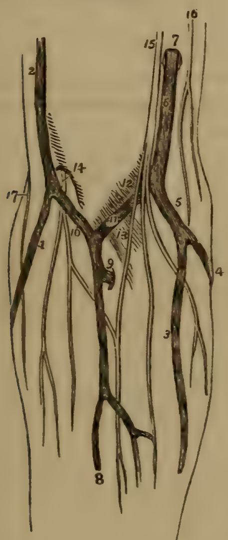


Fig. 553.

Anatomical relation of the veins in the bend of the elbow.

vessels from which the surgeon may draw blood: the radial vein (1) is on the outer side of the forearm, between the skin and superficial fascia, is crossed by (17) the spiral cutaneous nerve, a branch of the musculo-spiral, and is surrounded by a large number of nervous filaments; the median (8) is about midway of the upper part of the forearm, and divides above into two branches, one going to the cephalic (2), forming the median-cephalic (10), and the other to the basilic, forming the median-basilic (11); the anterior (3) and posterior (4) ulna are upon the inner side of the arm, and join above in a common trunk (5), which empties into the basilic; the median-basilic crosses the brachial artery, separated from it by a slip of fascia from the tendon of the biceps (13) at the point marked by the figure 12, which rests upon the deep fascia; in Fig. 553 this fascia is turned back, exposing the artery beneath; the internal cutaneous nerve (15) divides into several branches, which pass across the median-basilic; the external cutaneous nerve (14) pierces the deep fascia, and, dividing into two branches, passes behind the median-cephalic, which is surrounded by several nervous filaments; the intercosto-humeral cutaneous nerve (16) runs along the outer side of the basilic.

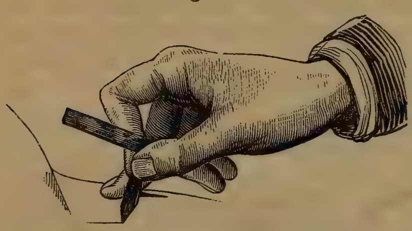
The veins are more or less surrounded with nervous filaments, so that it will be impossible to avoid wounding some of them in venesection, nor does experience teach us that it is of much consequence if they are. The proximity of the median-basilic to the brachial artery should put us on our guard when opening that vein; and, indeed, if there is any choice offered, it should be avoided altogether. The posterior ulna is sometimes quite large, and offers then the most eligible spot for the operation; though, upon the whole, the median-cephalic will be the safest and most convenient vein.

If a sudden impression is desired to be made upon the system, and syncope is induced, the patient should be bled in the erect posture; while, on the contrary, if the full depletive effects of the operation are sought, he must lie down.

After the surgeon has selected the vein he intends to open, which is ordinarily visible through the skin (though in children and corpulent persons it is not always so, and then the sense of touch will enable us to make out the position of the vessel), the circular bandage is placed around the arm, some distance above the elbow; this consists of a strip of muslin one and a half inch wide and a yard long, and is applied by placing its body upon the front of the arm, conducting its extremities around the limb, and finally bringing them forwards again to be tied in a single bow-knot upon the outer side of the arm.

The bandage should be drawn sufficiently tight to arrest the circulation in the veins without disturbing that in the arteries; the surgeon then takes the lancet by its blade between the thumb and index finger, while the middle finger, resting upon the forearm, supports the hand, as seen in Fig. 554; with the left hand the forearm is grasped in such a manner that the corresponding thumb may be used to steady the vein, while it is being punctured. The point of the thumb-lancet is now thrust forwards obliquely, by simply extending the thumb and finger, into the cavity of the vein, which is known by the absence of further resistance to the progress of the instrument, and then withdrawn by slightly elevating the point to enlarge the orifice to the desired extent. If the operation is well done, the blood will flow in a continuous stream, and should be caught in a common basin, or in one of those graduated vessels especially made for this purpose, and called a "palette."

Fig. 554.



Mode of holding the thumb-lancet in bleeding.

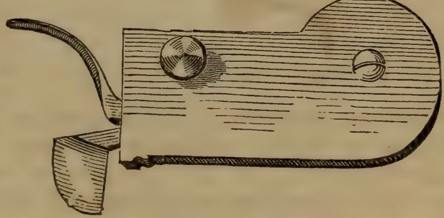
Should the blood not flow freely enough, the patient may be directed to grasp something in his hand, and to close and relax the fingers alternately. The exit of the blood may be hindered by the loss of parallelism between the incision in the skin and wall of the vein, caused by some movement on the part of the patient; to remedy this the limb should be restored, as nearly as possible, to the position in which it was when the incision was made; or a little clot of blood or

granule of fat may come between the lips of the little wound; they must be removed with the point of a probe or a pair of forceps. In case the ligature upon the arm is drawn so tight as to obstruct the passage of the blood from the arteries to the veins, it must be promptly loosened until the blood issues freely. The desired amount of blood having been drawn, the surgeon places his left thumb over the incision, removes the circular bandage from the arm, which should be cleansed from blood with a moist sponge, and slips beneath the thumb a small compress an inch square by half an inch thick, made of a piece of linen folded; the compress is secured in position by the figure of 8 bandage of the elbow, taking care to draw its lower convolutions tighter than the upper ones that efficient pressure may be made upon these veins anastomosing with the vessel opened. The arm is now flexed at a right angle, and supported in a sling depending from the neck, for thirty-six or forty-eight hours, when the wound will be found cicatrized.

Should it be necessary to repeat the bleeding within the twenty-four hours, the same vein may be again opened with the point of a probe; or if this has been anticipated, a little piece of simple cerate placed between the margins of the incision will prevent its healing, upon the removal of which the blood will flow freely; but it is a better plan always to make a fresh incision.

The spring-lancet is sometimes employed in venesection; the instrument consists of a blade or fleam inclosed in a metallic case, and acted upon by a strong spring; when in use the blade is drawn up with the handle projecting above it until its point is above the lower edge of the case, in which position it is held by a trigger, and not permitted to be driven down unless the button upon the side of the case is pressed upon. The arm having been prepared in the same manner as in the previous case, if the vein is superficial the edge of the fleam should be held a little above the skin; but, on the contrary, if it is deep seated, the point of the fleam ought to touch the surface, in order that the cavity of the vessel may be surely reached; the blade is then driven into the vein obliquely by pressing the button of the spring, and quickly withdrawn.

Fig. 555.



Spring-lancet.

Some accidents have followed venesection which require notice in this place, as great alarm has often been caused the patient, where there has been no occasion for it, by some unusual complication of little moment; for instance, the cutaneous incision may be very narrow, or lose its parallelism with the perforation in the wall of the vein, so that the blood escapes into the cellular tissue, and gives rise to an ecchymosis several inches around the puncture; the blood in this case will be absorbed in three or four days. From the same causes the blood may

coagulate around the vein, forming a tumor called a thrombus, which also usually disappears without any bad consequence, though it may excite inflammation and suppuration, and demand the use of the lancet to evacuate the pus.

As the veins are surrounded more or less with nervous filaments, some pain may be caused in irritable subjects, which may be removed by the application of the watery solution of opium; convulsions and tetanus have been stated to have originated from the same cause.

As inflammation of the lips of the wound, phlegmon, erysipelas, and angeioleucitis, may happen from special causes in any sort of wound, they are simply mentioned here as having been occasionally seen to follow venesection.

Phlebitis is always a serious complication of wounds, and may occur in phlebotomy; the veins become hard like cords, and the whole limb œdematous. The proper remedies for phlebitis are the application of leeches, and, after their removal, narcotic poultices. It has been recommended to tie the vein above the puncture to prevent the pus getting into the circulation; with the same view Abernethy advised the vessel to be divided instead of ligatured; free incision at the seat of the wound, combined with pressure, will also be found advantageous.

Puncture of the tendon of the biceps muscle has also been pointed out as a redoubtable accident upon insufficient grounds.

Wounding the brachial artery in venesection has often occurred, and may result in either traumatic aneurism, or aneurismal varix; the blood, in the former instance, being poured out into the surrounding cellular tissue, and in the latter into the cavity of the vein through the orifice made in its posterior wall by the lancet. In the aneurismal varix the blood will issue in jets, or per saltum, as it is called, and be of a scarlet color, and somewhat frothy. Pressure upon the brachial artery above arrests the hemorrhage at once; but not at all, or very slowly, if the pressure is made upon the entire circumference of the limb. The pressure should be exerted upon the artery in the axilla, that no mistake can occur from its bifurcation taking place high up the arm. From these symptoms, if it should be ascertained that the artery has actually been pierced with the lancet, the arm should be inclosed in a roller bandage from the fingers to the shoulder, and a graduated compress placed over the puncture, with

Fig. 556.

Mode of arresting hemorrhage from the brachial artery at the bend of the elbow, after venesection.

its apex downward, in the manner shown in Fig. 556; *a*, is the artery, and *b*, *b* the compress. To sustain the compress, apply over it a figure of 8 bandage pretty firmly.

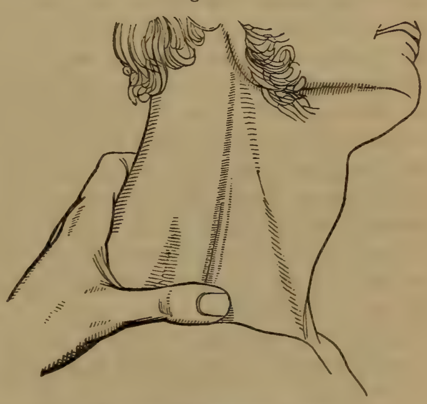
By this treatment it sometimes happens that the wound in the artery cicatrizes in three or four days, and no further trouble is experienced; under other less favorable circumstances, a pulsating tumor is formed, which will demand an incision to be made over the bleeding artery, and a ligature applied above and below the wound.

Both the salvatella and cephalic veins of the hand have been opened in venesection. A circular bandage placed around the wrist with sufficient firmness, will cause them to swell sufficiently, so as to be easily punctured with the lancet. Should the ligature not render them prominent, the hand may be soaked a short time in warm water. There are no arteries in the way, and the only caution necessary is to avoid wounding the sheaths of the extensor tendons. When the radial artery, instead of following its usual course, mounts over the extensors of the thumb, it will be found running parallel with the cephalic vein.

The cephalic vein of the arm is found between the deltoid and pectoralis major, and may be exposed by an incision an inch long in front of the shoulder, over the inter-muscular space. Velpeau recommends the vein to be sought just above the inner condyle, where it is more superficial; bleeding from this vessel is rarely ever practised at present.

It was formerly recommended, in certain cases of cephalic disease, to bleed from the external jugular which crosses the neck obliquely, lying between the superficial fascia and the platysma myoid muscle, and empties in the subclavian behind the clavicle. The operation is performed by placing over the vein a compress just above the clavicle, and confining it in the position with a cravat, the body of which is laid over the compress, and its tails tied beneath the axilla of the opposite side, in order to prevent the return of the blood in the vessel. (Fig. 558.) The point that should be selected for the puncture is just below the middle of the vein, where the vessel is largest, and surrounded with fewer nervous filaments. The vein must be steadied by the thumb (Fig. 557), while the thumb-lancet, held in the right hand in the manner we have described, is thrust into its cavity in an oblique direction, so as to cut the muscular fibres of the platysma at right angles to their course, that their retraction may allow a sufficient opening for the blood to flow out freely. A card or piece of tin, bent in the shape of a gutter, and placed below the point of puncture, will conduct the blood away into a vessel ready at hand to receive it.

Fig. 557.



Bleeding at the jugular vein.

Should the blood not issue with sufficient rapidity, the patient may be directed to perform the movements of mastication, which will force the blood from the deeper veins into the more superficial ones.

To arrest the bleeding, place the finger over the puncture, remove the compress and bandage at first applied, and put a compress upon the wound to which it must be secured by a cravat, the base of which is laid upon the neck and shoulder of the opposite side, its tails crossed over the compress, and finally tied together beneath the axilla of the side upon which the vein was punctured.

The veins of the foot are small, and therefore ineligible for venesection; by their junction, however, they form two large trunks, the internal and external saphenous, which may be opened with the lancet. The external saphenous is situated between the external malleolus and the tendo-Achillis, and is in relation with a nerve of the same name; the internal saphenous lies upon the inner malleolus between the skin and periosteum; this vein is larger than the former, and is generally selected for the operation.

To enlarge the veins about the ankle, the foot must be placed in warm water, and a circular bandage applied to the leg three or four inches above the malleoli, then the most prominent vessel being selected, it is steadied with the thumb of the left hand which grasps the foot, while the point of the lancet is shoved into its interior with the fingers of the right hand, almost parallel with the vessel, in order to avoid penetrating the periosteum or bone. The flow of blood may be increased by keeping the foot immersed in warm water contained in a pail, though it has the disadvantage of interfering with a correct estimate of the amount of blood drawn; the bleeding may also be accelerated by the patient moving his toes.

When a sufficiency of blood has been obtained, the circular bandage is removed, and a compress confined over the wound with the figure of 8 bandage of the ankle.

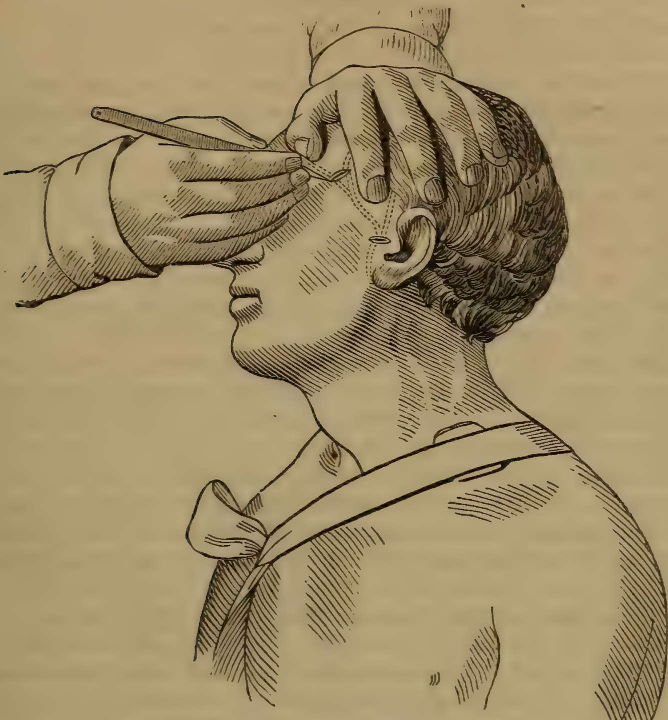
If the point of the lancet should, by any accident, penetrate the bone, the wound may be enlarged a little and the point removed; though should the little fragment of metal be permitted to remain it will, perhaps, cause a phlegmon to form, and be finally eliminated with the pus.

Arteriotomy.—The only artery that has been opened in later times for surgical depletion is the temporal, and that is now nearly abandoned by most surgeons; the ancients, besides this one, did not fear to cut the mastoid, and even the radial.

If it is ever desirable to perform this operation upon an artery, the anterior branch of the temporal is of sufficient size to afford the requisite amount of blood, besides possessing the advantages of being superficial and easily compressed upon the temporal bone to check the hemorrhage; and there are no important parts adjacent that we need fear wounding.

The operation is performed either with a lancet or a bistoury (Fig. 558). The artery being held by the index and middle fingers, an incision is made three-fourths of an inch long, at right angles with its course,

Fig. 558.



Mode of dividing the temporal artery in arteriotomy.

dividing half the diameter, or thereabouts, of the vessel. The object of this is to prevent the retraction of the extremities of the artery, which would be likely to defeat the aim of the surgeon, inasmuch as the orifices would then be drawn into the cellular tissue, in which the blood would coagulate and seal them up.

Fig. 559.

Bandage and compress applied after arteriotomy.

When the bleeding has gone far enough, the instrument is used again to cut the vessel completely through to permit the divided ends to retract; a compress is placed over the wound and supported by a roller bandage, as seen in Fig. 559.

The artery is usually obliterated in eight or ten days, though a traumatic aneurism does sometimes result, requiring the ends of the artery to be tied.

SECTION II.

LOCAL BLEEDING.

Local bleeding is generally performed over, or as near to the diseased part as possible, for the purpose of abstracting blood directly from it. In some cases, from necessity, the point upon which the operation is performed will be more or less remote from the diseased organ, as in the abstraction of blood from the temple in diseases of the eye, and from the hæmorrhoidal vessels in affections of the brain. The first method is by far the most serviceable and the one commonly employed in surgical practice.

Local depletion may be effected in two modes: first, by cupping; and second, by leeching.

1. Cupping consists in the application to the skin of a bell-shaped vessel, now made of glass, technically called a " cup," by rarefying the air contained within it by means of heat, or a sort of air-pump. In this way the integuments are made turgid and red, and are forced up some distance into the cup by atmospheric pressure.

This action produces a derivative effect by drawing the blood from the morbid tissues beneath, whose capillaries are thereby placed under more favorable circumstances for restoration to health; this is called *dry cupping.*

If a more decided and permanent derivative effect is required, the integuments are scarified so that, upon the reapplication of the cup, the blood will flow out from the capillaries freely, constituting *wet cupping,* or, as it is sometimes named, *cut cups.*

Cupping glasses are usually supplied, by surgical instrument makers, of different sizes, holding from one to four ounces, destined for application to the various localities of the body, upon all of which it would be impossible to put glasses of the same dimensions. Should these not be at hand, however, the ordinary wineglass or tumbler will answer as a good substitute.

The person to be cupped should be placed in a convenient position, and arranged in such a manner that his clothes may not be soiled with the blood; the skin upon which the operation is to be performed is then bared and wiped clean with a sponge dipped in hot water, which will at the same time tend to congest the capillaries, and thus render the bleeding freer. The operator takes a cup in his hand, and either dips it in hot water, or holds it for two or three seconds over the flame of a spirit lamp, to rarefy the air in its interior, and quickly claps it upon the skin; a better plan is to moisten the interior of the glass with alcohol, or put into it a thin piece of paper dipped in that fluid and set fire to before the cup is applied.

The integuments will rise immediately into the mouth of the glass, and present a red, turgid appearance.

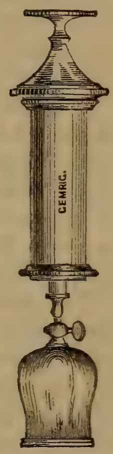
A second mode of rarefying the air inside the cup is with an air-pump, which is made with a socket at its extremity to fit the nipple-like projection upon the tops of the glasses; the projection is pierced with a small aperture and covered with a little slip of gold beater's

skin or oiled silk to serve as a valve, or, as a better arrangement, still it bears a stopcock, as seen in Fig. 560. With this instrument the air is gradually exhausted from the glass by repeated strokes of the piston, until the skin is sufficiently turgid, when the stopcock must be turned, and the air-pump removed.

To do away with the inconveniences of the air-pump, among which we may mention as the chief its liability to get out of order, it has been suggested to attach an India-rubber ball to the top of the cup and make the vacuum with that, by grasping the ball in the palm of the hand and alternately compressing and relaxing the hold upon it (Fig. 561).

Whichever plan is pursued, the glasses must not be exhausted too much, for if they are, their edges will probably bruise the skin, prevent the flow of blood, and at the same time cause considerable pain.

Fig. 560.



Mode of attaching an air-pump to the cupping-glass.

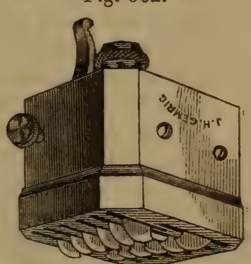
Fig. 561.

Cupping-glass with India-rubber ball attached.

To remove the cup it will be necessary simply to cant it a little to one side, and with the tip of the finger press the integuments away from any point of its rim, which will permit the entrance of air into the glass and destroy the vacuum.

In applying cut cups the same methods are pursued as described above, and when the skin is sufficiently congested the glass is removed and incisions are made upon the reddened surface; this may be accomplished either with the lancet, bistoury, or *scarificator*, the latter being the most expeditious and least painful manner. This instrument, as seen in Fig. 562, consists of a square metallic case containing from twelve to fifteen broad, sharp blades, attached to two stems of metal revolving through a quarter of a circle, and driven by a strong spring; the depth of the cut may be graduated by raising or depressing the blades with the screw-head seen upon the top of the instrument; the blades are drawn into the case by

Fig. 562.



Scarificator.

pulling back the lever placed by the side of the screw-head; the lever is held by a catch.

The instrument thus arranged is ready for use, and is laid flat upon the surface to be scarified; then, by exercising pressure with the thumb upon the little button seen upon its side, the trigger is sprung, and the blades driven into the skin.

After the incisions are made, the glasses are again applied, when the blood will readily flow into them in quantity varying with the size of the cups and the vascularity of the parts; perhaps, on an average, an ounce will be drawn by each cup, but should it be necessary these may be reapplied several times, until the desired amount of blood is obtained. A basin of warm water should be at hand, and two or three soft towels and sponges; the cups, one after another, are then seized in the fingers, and having been depressed upon the side, are quickly removed with a sort of scooping motion to catch the clotted blood, assisting the operation with a sponge held in the opposite hand. In this manner the patient's clothes will not be soiled at all. The surface may be now gently cleansed with warm water, and dried with a towel; generally, no dressing will be required, but should the incisions be sore or painful, a soft rag, moistened in glycerine, or water-dressings, will be the most appropriate applications.

Cups should not be placed over osseous projections, nor indeed upon any surface where there is not a sufficient amount of soft tissue to give them ample support. There are other situations where their application is manifestly impracticable—as in the interior of cavities, upon the eyelids, testicles, &c. Yet even these difficulties have been surmounted in some degree by the cups of Toirac, which consist of long, narrow glasses, connected by an elastic tube with an air-pump, that are capable of being applied to the bottom of any cavity whatever. M. Sarlandière invented an instrument called a *bdellomètre*, which combines in its construction the air-pump cupping-glass with the scarificator, so that the whole operation of cupping can be accomplished in one application of the instrument.

Prof. Simpson, of Edinburgh, has used an instrument for cupping the interior of the uterus in amenorrhœa; it consists of an air-pump and a perforated tube, sufficiently large to hold several drachms of blood, connected together. The tube is curved, and has a ring of gutta-percha upon it, rounded in such a manner as to accurately close the os uteri when the point of the instrument is in the cavity of that organ.

M. Junod recommended the use of cups sufficiently large to inclose portions of the body, as the leg or arm. He employed a copper cylinder, in which the limb was to be placed, and rendered air-tight by a strip of India-rubber surrounding the limb and the upper end of the cylinder; to the latter an air-pump is attached to make the vacuum, which can be regulated by an instrument connected with the cylinder. With this apparatus the most powerful and rapid derivative effects can be obtained, that syncope may be induced in a brief space of time.

Leeching.—For the purpose of local depletion, leeches, in many

cases, offer decided advantages; indeed, some parts of the body, from their situation within the interior of the natural cavities, peculiarity of form, or from diseased condition of their surfaces, cannot be easily depleted in any other manner. There are two kinds of leeches employed in this country, which it is necessary to be able to distinguish, as they differ materially in the amount of blood which they are capable of abstracting. The foreign leeches (*Sanguisuga officinalis* and *medicinalis*) are gathered in Sweden, and several parts of the south of Europe, from the marshes and running streams, and imported from London and Paris. They vary from two to four inches in length, and are marked upon their backs, which vary from a blackish to a grayish-green, with six longitudinal ferruginous stripes, the four lateral ones being interrupted with black spots; the belly, in one variety, is of a yellowish-green color, bordered with longitudinal black stripes; in the other, of a green color, bordered and spotted with black. Each of these animals will draw rather more than a half-ounce of blood.

The indigenous leech (*Hirudo decora*) is usually from two to three inches long, though it sometimes attains a length of five inches; its back is of a deep green color, with three longitudinal rows of square spots, and the belly of a brownish-orange color, irregularly spotted with black. The animal does not make so large a wound in the skin as the former, and it requires at least six of them to extract one ounce of blood.

The mouth of the leach is placed in the centre of the anterior disk, and is composed of three cartilaginous jaws, each armed with two rows of fine teeth meeting in such a manner as to make a triangular wound in the integuments.

In applying the animals to the skin, care should be taken to have it well cleansed of all foreign matters clinging to it either from the applications that may have been used, or from the secretions; the hairy parts of the body should be thoroughly shaved, so that the hair may neither interfere with the action of the leeches nor become clotted with blood.

The leeches are then put on inclosed in a tumbler; or, if there are many of them, laid first upon a napkin spread upon the palm of the hand, and then clapped to the skin, the fingers being used to hold the edges of the cloth all around, so that they may not escape. Vigorous leeches will generally take hold upon the skin without delay; but should they not do so, milk, cream, or sweetened water smeared over the surface will almost always tempt them to bite; some persons obtain a little blood from the tip of the finger by pricking it with a needle, which they rub upon the skin with the same object.

An increased activity may be excited in the leeches by covering them with a cupping-glass, and rarefying the air contained in it by a few strokes of the air-pump. Another mode recommended as very efficient is to put the leeches first in a tumbler half full of cold water, and by a quick movement invert it over the part to be depleted; the animals will seek the warm skin immediately, and quickly attach themselves to it, when the water may be permitted to run from the glass upon cloths placed to receive it.

To bring leeches in contact with the interior cavities, the vagina or rectum, for instance, a speculum should be first introduced, then a leech is placed in a glass tube, or one formed from paper or a card; and when its point is at the spot where the animal is to bite, the latter should be shoved forward against it by a pencil, or little stick running through the tube; the tube may also be employed to bring the mouth of the leech in contact with any part of the buccal or nasal mucous membranes.

When the leeches are gorged, they will generally relax their hold and drop off, though should it be necessary to arrest their action at an earlier period than that, a little salt, snuff, or ashes, may be sprinkled upon them; no tractile force should be exercised for this purpose, as it is calculated to damage the jaws of the leech, and leave a portion of the suctorial apparatus sticking in the skin.

It has been proposed, in order to increase the rapacity of the leech for drawing blood, to clip off the point of his tail, after he is gorged. The operation is rarely successful, and always fatal to the animal; besides, after the leech falls off, the bleeding may be continued by the application of warm water-dressings, poultices, or a cupping-glass, so that really there is no necessity for this barbarous treatment.

In some instances the hemorrhage continues after the leech-bites have been exposed to the air without any of these warm applications, and to such an extent as to call for the interference of the surgeon. Generally, the compression exercised upon the wounds by a little cone formed by twisting a piece of lint or charpie, and a roller bandage, will suffice to stop the bleeding. Another efficient remedy is the introduction of the fine point of a stick of nitrate of silver into the bite; others have found it necessary to employ the actual cautery or the twisted suture, before the hemorrhage could be arrested; such cases must be rare, and mostly occur in persons of the hemorrhagic diathesis.

Saturated solutions of alum, of sulphate of zinc, the liquor of the persulphate of iron, and other astringents, are also efficient applications, and may be used upon pledgets of lint thrust into the wound with a needle, and supported with a compress and roller.

Accidents have happened from the leeches getting into the stomach and rectum, as in the cases observed by Baron Larrey, where they were swallowed with the water that soldiers drank from the pools in Egypt. They have also been known to detach themselves from the nasal and buccal mucous membranes, and escape into the stomach. The remedy in these cases is the prompt administration of salt water or vinegar in the form of a drink, or as an injection if the animals have crawled into the rectum.

Wounds of the temporal artery and external jugular vein have been seen to result from leech-bites; compression will succeed in arresting the hemorrhage from those vessels.

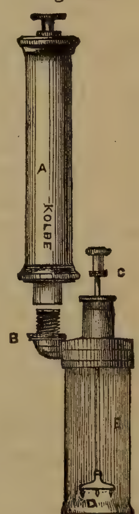
The classes of cases in which leeching is employed, are in the treatment of the inflammatory diseases of infants where abstraction of blood is indicated, and in whom general bleeding cannot be performed with safety; and in the local inflammations of the various organs of the body, in which leeching is both depletive and counter-irritant. In

phlegmonous erysipelas it has been advised to abstain from the use of leeches, upon the supposition that their bites would add to the severity of the malady; but the objection does not appear to be sustained by actual observation.

The arrangement and care of leeches is an important matter, and deserve a moment's consideration. After the animals have been once applied, the blood may be removed from their stomachs by throwing them into a solution of common salt, sixteen parts to a hundred parts of water; then remove them one by one, and holding the animal by the tail in water that feels hot to the hand, draw him gently through the fingers to expel the blood. After this treatment they should be placed in clean, fresh water, which must be changed once a day; on the eighth day, they may again be used when required.

Leeches are liable to epidemic diseases, which destroy them rapidly; and the best means to preserve them from these, as well as to sustain them in vigorous health, is to place them under those natural conditions, as near as can be, in which they are found. For this purpose numerous methods have been suggested, of which the simplest is, to select a jar in which soft clear water is put, throw the leeches into this, and keep the jar covered with a linen cloth; the water must be changed twice a week in winter and once a day in summer, care being taken that all slimy matter adhering to the animals is removed.

Fig. 563.



Kolbe's mechanical leech.

In a state of nature leeches clean themselves of this slimy material, upon the freedom from which their health so much depends, by crawling through the interlacing mosses of the marshes in which they live.

To furnish a condition analogous to this, it will be advisable to put in the bottom of the jar some earth, or, better still, clumps of peat.

Mechanical Leeches.—An effort has been made, without much success, however, to furnish an instrument for local depletion, resembling in its action that of the leech. The figure (563) illustrates the manner in which this instrument may be made.

It consists of a suction-tube (E) and an air-pump (A) connected by the screw B; C is a rod working air-tight through the cap of the suction-tube, and armed at its lower extremity with three sharp points (D) to puncture the skin.

CHAPTER XII.

EXTRACTION OF THE TEETH.

The extraction of the teeth claims a place in a treatise of this character, as it is an elementary operation for the performance of which country practitioners and the medical officers of the army and navy are often called upon. In cities, a special class of persons are commonly charged with this duty, who by continual practice acquire sufficient manual dexterity to save the patient a good deal of suffering, and also, perhaps, from accidents of a serious character which have often happened at the hands of ignorant persons.

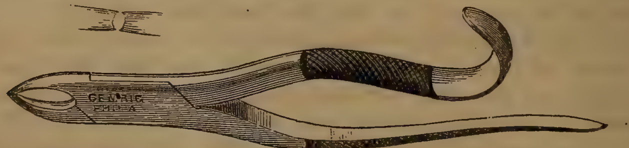
The extraction of a tooth, though so simple in appearance, requires, nevertheless, some surgical knowledge and dexterity for its correct performance; for an unskilful hand has produced fracture of the alveolus and antrum maxillare, wounds of the gums, and in some cases, serious nervous disturbance in delicate females; hence, every surgeon, who may be liable to be called upon to perform this operation, should at least familiarize himself with the proper method of accomplishing it.

From the manifest inadaptability of the "Key of Garengeot" to the extraction of the incisor teeth, the forceps have always been used for this purpose; and since 1830 so many improvements have been made in their construction, that now operators almost exclusively employ them upon the molars as well.

Forceps require more skill in their use than the "key," but they are at the same time a safer instrument, inasmuch as the power exerted upon the tooth is mostly parallel with its length, or the direction it takes in being dislodged, while the action of the key is exactly the reverse.

For the proper performance of the operation, at least seven pairs of forceps are required. One pair for the upper incisors and cuspidati; which, as seen in Fig. 564, have straight grooved jaws sufficiently thin

Fig. 564.



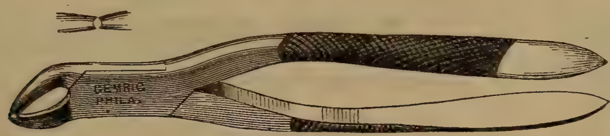
Forceps for the upper incisors and cuspidati.

at their points to be introduced between the gum and neck of the tooth; the handles should be strong enough not to spring in the hand

when firmly grasped; the extremity of one of them is turned up so as to prevent the hand slipping by hooking around its ulnar border.

The necks of the lower incisors being narrow, the forceps intended for them should have very narrow points, and the jaws curved below

Fig. 565.



Forceps for the lower incisors and cuspidati.

the articulation so as to form an angle of twenty degrees with the handles (Fig. 565).

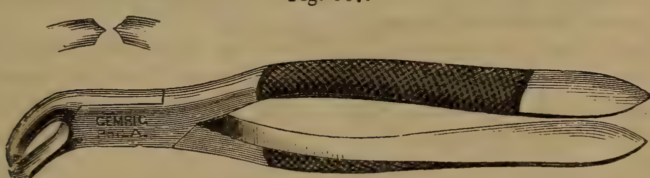
For the extraction of the bicuspidati of both jaws the forceps seen in Fig. 566 are well adapted; their points are broadly grooved, so as to take a good hold of the tooth.

Fig. 566.

Forceps for the bicuspidati.

For the lower molars but one pair of forceps will be required; they should be strong, and curved at the beak in front of the articulation; each point has two grooves, with a projecting tip between them, so

Fig. 567.



Forceps for the lower molars.

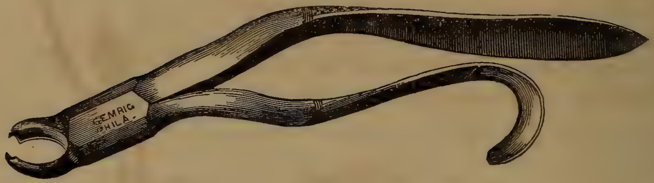
situated that in grasping the tooth the points will lodge upon either side of it below the bifurcation of the roots. The handles may be straight, as seen in Fig. 567, or, what is better, have one of them curved at its extremity so that the hand may not slip.

From the anatomical arrangement of the roots of the upper molars two pairs of forceps will be necessary, one pair for those upon the right side, and the other for those upon the left. Their jaws are curved in front of the articulation, and the handles behind it; it will be seen in the annexed wood-cuts, Figs. 568, 569, that that point which is to be applied to the palatine face of the neck of the tooth is simply concave, while the opposite one is both grooved and pointed to catch between the bifurcation of the roots upon its external side.

Fig. 568.

Forceps for the right upper molars.

Fig. 569.



Forceps for the left upper molars.

From the position of the dentes sapientiæ far back in the mouth a peculiarly constructed instrument is called for, such as is shown in Fig. 570; the jaws resemble in form the letter Z, and enable the surgeon to

Fig. 570.

Forceps for the last molars.

get a firm grasp upon these teeth, without being interfered with by the teeth of the lower jaw.

For the purpose of removing the roots of the teeth the narrow pointed forceps above described will answer very well, though considerable assistance may be derived from the screw and elevator, the forms of which are so well known as not to require any special description in this placc.

In applying the forceps the points of their jaws must be shoved well in between the gums and neck of the tooth, and just sufficient amount of pressure made upon the handles to insure the instrument from slipping; then, if it is a front tooth that is being extracted (Fig. 571), move the forceps backwards and forwards two or three times; give them a little rotatory movement, and lift the tooth upwards from its socket. In extracting the molars the forceps must be moved laterally to loosen the tooth, and the force then applied in a perpendicular direction with its axis.

Some have deemed the preliminary use of a lancet necessary in separating the gums from the teeth; but this is not at all required if the jaws of the forceps are well forced up around the neck of the tooth (Fig. 572).

The instrument sometimes employed in extracting teeth called the "key" was invented by Garengeot: and since his time it has undergone various modifications, both in the shape of the stem, and in that of the fulcrum.

The "key-bit" should be of sufficient width to be placed upon the gums at an advantageous distance from the tooth to be extracted. If too near this, the crown of the tooth will be broken; if too far, the alveolus will

Fig. 571.

Forceps in extracting lower incisor.

Fig. 572.

Forceps in extracting upper molars.

suffer a similar fate. To the "bit" the hook is to be secured with a pin provided with a thread, so that the former cannot become detached from the fulcrum. The hook is curved, and terminates at its point in an edge about one-sixteenth of an inch in width, with a little notch at its centre dividing the edge into two little points, which are intended to prevent the instrument slipping from the tooth. The stem of the key is curved where it joins with the fulcrum, so that it may not be interfered with by the front teeth when we are operating upon the molar. The handle is fitted crosswise the stem, and secured to the latter by a milled-head screw, removable at pleasure, so as to make the instrument more portable, and if there is need, permit the handle to be used in connection with the stem of any other instrument.

By withdrawing the pin from the "key-bit" the hook may be detached and changed to either side of the fulcrum, as the necessities of the case require. Two or three hooks of different sizes should always accompany the instrument, adapted to the varying dimensions of the tooth.

In operating with the key, we select a hook of the proper size, and fasten it to the fulcrum, taking care to envelop the latter with a piece of bandage or the end of a napkin, so that the gums may not be wounded by its pressure.

The handle of the instrument is held in the right hand, while with the index finger of the left we guide the hook to the tooth we wish to remove, and force its edge between the gum and inner surface of its neck near the edge of the alveolus, as seen in Fig. 573; then by a gentle twisting movement the tooth is made to move towards the

Fig. 573.

Mode of using the key in extracting teeth.

fulcrum, and at the same time upwards; when completely loosened in this manner, by elevating the key the tooth is removed.

As a general rule the fulcrum is placed upon the outside of the gum; though should the tooth have a decided curve towards the tongue, or have its inner wall destroyed by caries, the fulcrum may be established upon the inner side of the dental arch.

Extreme pain is almost always caused by the extraction of teeth, whether performed with the forceps or the key, which usually disappears in a short period, but may last for several days. Fractures of the alveolus sometimes occur; if the fragment is small, it will generally escape after the lapse of a few days; a large piece of bone should be supported in its natural position, and it will soon become reunited to the jaw. By a bungling operator, the teeth adjacent to the one he wishes to remove may be loosened, or even broken.

It rarely happens that there is much bleeding after extraction, though cases are recorded in which the hemorrhage was obstinate; should such an instance be encountered, a good plan to pursue is as follows: Soak a small ball of cotton or charpie in the tincture of the perchloride of iron, and press it into the tooth socket firmly; over this place other pieces of the same material until the alveolus is quite full, and the plug projects above the crowns of the two adjacent teeth; then mould a piece of sheet lead over the plug, and after bringing the jaws firmly together, sustain them in this position by one of the bandages for the head and jaw already described.

Some persons have found it necessary to cauterize the alveolar cavity with the point of a hot wire.

CHAPTER XIII.

CATHETERISM.

Catheterism is the introduction of the catheter, sound, or bougie into any of the natural passages of the body, such as the urethra, Eustachian tube, or the nasal duct. When the word is used without a qualifying adjective, it simply defines the operation as performed upon the urethra.

Various instruments are used in executing this operation, according to the position and anatomical structure of the canal; though the results obtained in different cases are often identical: thus, the catheter may be introduced into the bladder and stomach for the purpose of removing their contents; or, again, with the view of overcoming a constriction or narrowing in the urethra or œsophagus. It

Fig. 574.

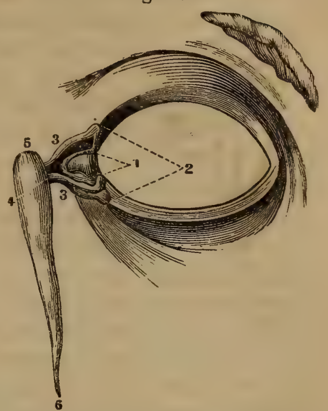


Diagram showing the anatomical relations of the canaliculi with the nasal duct: 2, puncta; 3, 3, canaliculi terminating by a common trunk (4) into the lachrymal sac (5).

becomes necessary sometimes to inject fluid substances into the Eustachian tube, nasal duct, trachea, and bladder.

Important information is, likewise, obtained by this operation, of the condition of the walls of these passages; it declares the presence or absence in them of foreign matters, as well as morbid alteration in their caliber. Introduced into the bladder, the sound serves as a guide for the knife in lithotomy; and with a peculiarly constructed catheter the surgeon is enabled to plug the nares so as to arrest profuse hemorrhage.

Catheterism of the Nasal Duct.—The nasal duct, lodged in the lachrymal canal, commences at the inner canthus of the eye in a slight enlargement, the lachrymal sac, into which the canaliculi empty—sometimes separately, but in almost all cases by one orifice, as seen in Fig. 574—and terminates in the inferior meatus of the nose in a slightly expanded orifice near its floor, and about six lines from the orifice of the nostril; it is about one-half inch in length and two lines in diameter, and slightly curved upon itself, the convexity being outwards; the canaliculi are about one line wide and three lines long, commencing upon the inner margin of the tarsal cartilages, the superior taking a direction upwards and inwards, the inferior downwards and inwards.

Fig. 575.

Anel's probe.

The operation may be performed through the puncta, through an incision at the inner canthus into the lachrymal sac, or through the inferior orifice of the duct, its object being in each case to dilate the nasal duct, and thus to restore the natural flow of the tears through it.

In the first instance, the operation is performed with delicate flexible probes of silver, invented by the French surgeon Anel. It is accomplished in the following manner: To dilate the upper canaliculus, the tarsal cartilage is seized between the thumb and index finger, and slightly drawn out; the probe is held in the right hand like a pen, with its point in the superior puncture, and pressed gently upwards about two lines, when the probe is brought parallel with the ciliary border of the upper eyelid; shoved inwards a little; then gradually raised vertically in a line with the supra-orbital notch, and pressed inwards and downwards into the lachrymal sac. The duct may be entered through the lower canaliculus by passing the point of the probe downwards about one-tenth of an inch into the inferior puncture, then inwards and slightly upwards.

When the nasal duct is to be dilated through an artificial

orifice, catguts and styles are employed, such as are seen in Figs. 576, 577, 578. The styles are made of silver or lead, and the sizes used are

Fig. 576.

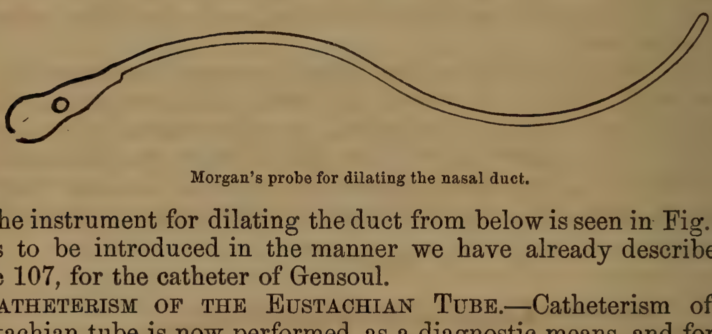
Fig. 577.

Fig. 578.

Styles for dilating nasal duct.

to be gradually increased from the smallest to the largest, as the duct yields. Fig. 578 shows a style that may be extemporized at any moment from a piece of lead-wire six to eight lines long, of the proper dimensions, rounded at one end and bent at the other.

Fig. 579.



Morgan's probe for dilating the nasal duct.

The instrument for dilating the duct from below is seen in Fig. 579. It is to be introduced in the manner we have already described at page 107, for the catheter of Gensoul.

Catheterism of the Eustachian Tube.—Catheterism of the Eustachian tube is now performed as a diagnostic means, and for the

Fig. 580.

Flexible tube, and the Eustachian catheter into which it fits.

introduction of air into the cavity of the tympanum. For the latter purpose, the instrument seen in Fig. 580 is employed.

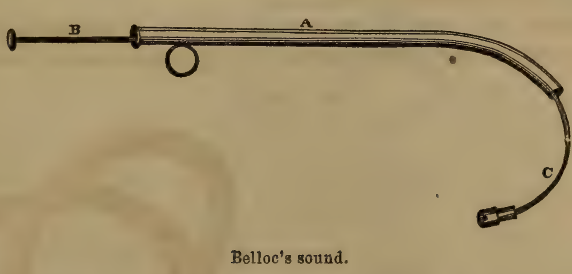
The catheter is introduced by holding it lightly between the thumb, middle, and index fingers, and passing its point backwards along the floor of the nares, with the convexity upwards. When about four inches deep, and the point has reached the veil of the palate, indicated by the acts of deglutition which it excites when it arrives at that place, the extremity of the catheter should be rotated against the outer wall of the pharynx to enter the orifice of the Eustachian tube, which is situated about eight lines above the plane of the floor of the nares. To assure himself that the beak of the instrument is in the orifice of the tube, the surgeon should gently pull the catheter forwards, when a feeling of resistance will be perceived if the operation is successful. The point of the elastic tube is now fixed to the catheter, which is to be sustained in the left hand, while the surgeon takes the other end of the tube in his mouth, and gently forces air into the cavity of the tympanum.

This operation is performed in certain cases of deafness for the purpose of removing mucus from the Eustachian tube, and liberating the lips of its faucial orifice after appropriate remedies have been employed to diminish the hypertrophy of the mucous membrane lining it.

PLUGGING THE POSTERIOR NARES.—Plugging of the posterior nares is a species of catheterism which we sometimes have recourse to, to control hemorrhage from the nasal fossæ, when either by its quantity or duration it becomes threatening, and after other simpler means have failed.

The operation is usually performed with a special instrument called the "sound of Belloc." It consists of a silver tube about seven inches long, curved at one of its extremities; the other extremity has a ring soldered to it corresponding with the side of the curve, which enables the operator to judge exactly where the point of the instrument is after it is introduced; through the tube a steel spring runs for half

Fig. 581.



Belloc's sound.

its length, having an eyed point, and fastened at the other end to a metallic stem (B), by means of which it may either be projected from or withdrawn into the tube.

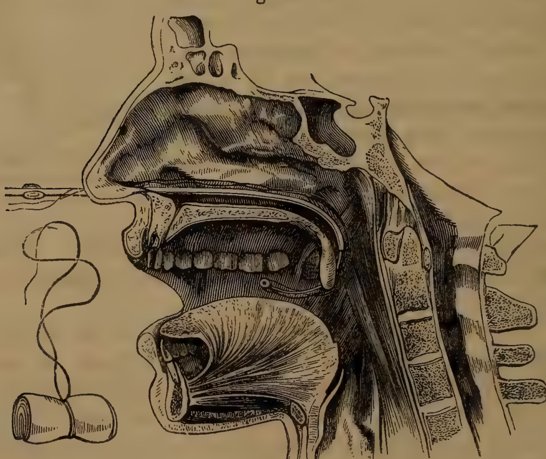
When this instrument is not at hand, an ordinary gum catheter can be used in the following manner: Take a doubled thread, and tie its loop or bight to the point of the catheter, which should be furnished with a wire stylet, so that it may maintain the curved form impressed upon it; then, holding the catheter with the free ends of the threads in the right hand, pass its beak along the floor of the nares, with its

point downwards, until it reaches the pharynx, when the stylet should be withdrawn a little, and the patient then directed to breathe forcibly; the point will then come sufficiently forwards to be grasped in a pair of forceps and drawn into the mouth; the thread should now be loosened from the catheter, and the latter withdrawn, when a plug of the proper dimensions, having a single thread attached to it, may be fastened in the loop of the doubled thread. A simple thread rolled into a little ball and placed in the nostrils will be drawn into the pharynx by directing the patient to make short and quick inspiratory actions with the mouth closed; the end of the thread may then be seized and drawn into the mouth.

Another expedient is to join a little sac of thin bladder or gold-beater's skin to the point of a catheter, and thrust this into the posterior nares, after which it may be distended with air or water. Similar to this is the instrument of M. Gariel, consisting of a gum-elastic tube capable of being dilated at one extremity into a size sufficient to fill up the posterior nares, and furnished at the other with a stopcock. After it is introduced into the nose, the tube is dilated either with air or water.

In using the instrument of Belloc, two compresses are to be made from patent lint or other suitable material, and of convenient size, one for the posterior nares, and the other for the orifice of the nose; to the centre of the former a double thread is attached, intended to be drawn through the nares, and also a single thread, destined to hang from the mouth, and by which the compress is withdrawn. Thus prepared, the surgeon now passes the "sound" through the nostril into the pharynx, and then thrusts the spring forwards by the metallic stem, which, from its curved form, enters the mouth from behind, and

Fig. 582.



Mode of plugging the nares.

may be seized with the fingers and held while the double thread is being passed through its eyed point; after this is done, the spring is drawn into the canula, and the instrument removed, bringing along

with it the double thread, which must be held in the left hand, and gentle traction made upon it, while the surgeon with his right index-finger guides the compress through the mouth and up behind the soft palate, leaving the single thread hanging from the mouth. The second compress is now placed over the meatus of the nose, and the double thread tied upon it. In this manner the hemorrhage is arrested; for the nares, being plugged anteriorly and posteriorly, become filled with blood, and pressure is thereby brought to bear upon the bleeding vessels. At the end of forty-eight hours the flow of blood will have been checked, and the plug may be removed by untying the thread over the anterior compress, and drawing upon that one in the mouth.

M. Bretonneau prefers the *kite-tail* plug to all other means of plugging in epistaxis. It is formed of a thread about forty feet long, to which, at intervals of about six or seven inches, pieces of carded cotton (to be oiled before using the plug) are attached.

Fig. 583.

Stricture of the gullet, at its most ordinary position, with a bougie introduced by the mouth.

CATHETERISM OF THE ŒSOPHAGUS.—Catheterism of the œsophagus becomes necessary under two conditions: first, when there is stricture; second, when we wish either to evacuate the contents of the stomach, or to introduce into it liquid aliments.

In the first case we use bougies made of lead, silver, or gutta-percha. M. Boyer employed silver sounds successfully. These instruments should be of different sizes, properly curved, and of sufficient length to reach beyond the stricture (Fig. 583).

To remove the contents of the stomach, or to inject nutrient fluids into it, a long flexible tube is employed, made of India-rubber or waxed cloth; one of its ends is furnished with a well rounded and fenestrated tip of gutta-percha, the other is connected with a small metallic force-pump; the pump itself is constructed with ball-valves, which are the most durable kind and least likely to get out of order, and has also attached to the side of its barrel a second tube of the same material as the first. In using the instrument, the œsophageal tube may be introduced into the stomach either through the nostrils or mouth.

To pass the tube through the nose, the larger meatus, if there is any difference in their size, should be selected; the patient is seated in a chair, or may lie upon his back, and is directed to extend the head in order to diminish the angle formed by the nares and the pharynx; then the tube, held in the right hand, is carried along the floor of the nose, keeping it well against the septum, to prevent its point catching against the turbinated bones; when it has reached the pharynx the patient must open his mouth widely to enable the operator to press the end of the tube with his index finger towards the left side that it may go more directly into the superior orifice of the œsophagus, the open-

ing of the larynx being nearer the median line. The instrument must now be passed slowly and gently into the stomach, which will be known by its being suddenly arrested by the pressure of the point upon the walls of that viscus.

The operation is but little difficult to execute, and with patience may be readily accomplished when the tube may be kept in the stomach as long a period as is required for the attainment of the object in view by fastening it with threads, after the manner of a catheter, to a T bandage of the nose.

If there is choice left, the mouth should always be selected for the introduction of the tube, inasmuch as this cavity, besides being more capacious, by simply throwing back the head, may have its axis brought in a line with that of the œsophagus. With the head in this position, the surgeon depresses the tongue with his left index finger, and holding the tube in the right hand he passes it into the throat; the irritation of the point of the instrument will at first cause the patient to retch, or even vomit; but the parts, in a brief period, become accustomed to its presence, and it may be pressed gently onwards to the stomach, avoiding the superior orifice of the larynx, and taking care not to perforate the walls of the œsophagus, which might happen should they have undergone softening from carcinomatous or other morbid conditions.

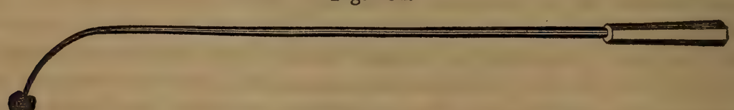
The tube may be kept in for some time, but it is more embarrassing to the patient than when introduced by the nose.

If the object is to evacuate poison from the stomach, the pump is now attached to the tube, and a quantity of water injected: this is removed, and more fresh water introduced; and this in turn pumped out; until by the repetition of the process the fluid removed is perfectly clean and clear, taking care never to empty the stomach entirely, as there is a risk of the mucous lining of the organ being damaged. In injecting fluids into the stomach the operator should be certain that the tube is in that viscus, for it has happened in several cases that instead of putting it into the stomach the lungs have been flooded, in one instance upon record with chalk mixture, and in another with soup. This is more likely to happen if the patient, during the operation, is insensible.

To prevent the tube being bitten, a wooden gag with a hole through it may be introduced between the teeth.

Catheterism of the Larynx and Trachea.—Dr. Horace Green, of New York, has established both the practicability and the utility of catheterization of the larynx.

Fig. 584.



Sponge probang.

He employs the instrument seen in Fig. 584, consisting of a stout whalebone handle about ten inches long and bent at its extremity, which

is mounted with a pellet of soft sponge, at an angle of nearly 45°. The operation is performed by seating the patient in a chair with his head thrown back and the mouth as widely open as possible; the surgeon presses the tongue down with a *depressor*, and holding the probang in his right hand, glides the sponge towards the epiglottis, at the same time directing the patient to take a deep inspiration, when the point of the instrument is slipped into the larynx. It needs to rest there but a single moment, and should be quickly withdrawn. The cases in which the operation has been performed are syphilitic and tubercular ulceration of the larynx, excrescences about the vocal cords, and œdema of the glottis. The application usually made use of is a solution of the crystallized nitrate of silver in water, of the strength of forty to sixty grains of the former to an ounce of the latter.

In the hands of Dr. Horace Green the probang has been carried into the trachea, and even as far as the bronchi.

CATHETERISM OF THE LARGE INTESTINES.—Catheterism of the large intestines is employed to relieve flatulent distension of the colon, and in stricture of the rectum.

In the first instance the long flexible tube of the stomach-pump will answer very well; it should be well oiled, and gently pushed into the rectum to as high a point as is requisite to remove the accumulated gas. I have on several occasions introduced this instrument to a distance of two feet into the bowel without any difficulty, and in very thin persons it may be felt in the transverse colon; if cold water is thrown in the patient first experiences its impression at that point of the colon corresponding with the point of the tube; showing clearly that the tube has not been doubled upon itself.

In the treatment of stricture of the rectum bougies of India-rubber, metal, wax, or wax-cloth are used; also several special kinds of dilators.

Their introduction should be accomplished with the greatest care, the smallest instrument being first employed that will pass the stricture, the size being insensibly increased as the constriction yields.

To overcome some of the objections to the bougie special dilators have been invented, which, when closed, form a slender stem that may easily pass the stricture, and then can be enlarged to any dimension by turning a screw placed upon the handle for that purpose.

In others constructed of India-rubber the dilatation is effected by the insufflation of air into their cavities.

CATHETERISM OF THE UTERUS.—Sometimes, from the narrowing or closure of the os uteri, catheterism becomes necessary, and may be effected with bougies made of metal, India-rubber, or waxed cloth; they should be of different sizes, and their introduction into the os effected with the greatest gentleness. The smallest size should be used at first, and permitted to remain two or three hours each time for a few days until the parts become accustomed to the presence of the instrument, after which other sizes are employed until the requisite amount of dilatation is effected. Special dilators have also been invented for the same purpose.

CATHETERISM OF THE URETHRA.—Catheterism of the urethra is

required to be performed in retention of urine from various causes—contraction of the voluntary or involuntary muscular fibres surrounding the urethra, paralysis of the bladder, stricture, etc.

In many cases other measures will often succeed in relieving the bladder, such as the immersion of the patient in a warm bath, the inhalation of the anæsthetics, the administration of a full dose of morphia or other narcotic, or an injection containing opium or camphor; sometimes the evacuation of the rectum by a large enema, or the free use of alkaline draughts will accomplish the same object: tincture of the muriate of iron in ten-drop doses every ten minutes is an empirical remedy occasionally had recourse to.

Catheterism of the Male Urethra.—The instruments used in this operation are cylindrical tubes made of silver, waxed cloth or India-rubber of different sizes and forms. The scale of sizes adopted by some of the instrument makers is shown in Fig. 585.

Fig. 585.

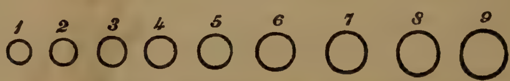
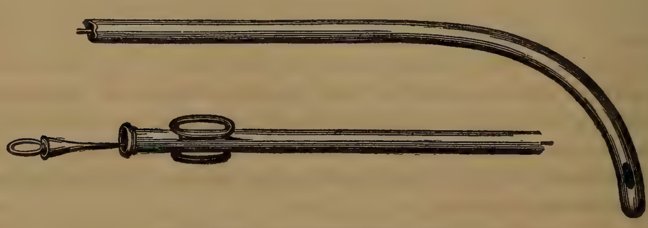


Diagram showing the sizes of catheters.

The catheter should be curved at its extremity to some extent, although a perfectly straight instrument may be made to pass into the bladder. The form seen in Fig. 586 is, perhaps, the best: in this the axis of the beak makes with that of the shaft an angle little less than

Fig. 586.



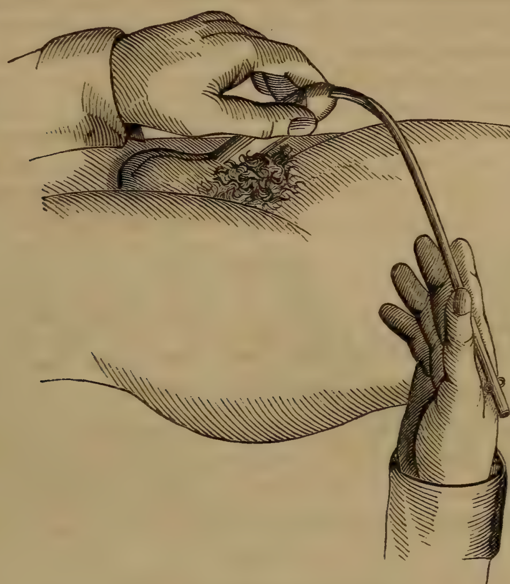
Catheter showing the proper curve.

a right angle; its point is well rounded, and pierced a short distance above with two oval holes or "eyes" at different heights; to the open extremity of the tube two little rings are soldered for the purpose of attaching a retentive bandage if required; and also to serve as an indication of the position of the point of the instrument.

Method of Introduction.—The patient may stand in front of the surgeon, while the latter sits in a chair, or he may lean with his back against a wall, or again, he may sit upon the edge of the bed, with his knees widely separated, and the feet supported on a stool; though the most convenient position both for the surgeon and patient is for the latter to assume a horizontal posture, with his shoulders slightly elevated, the thighs drawn up, and the knees wide apart. The surgeon having warmed, and well oiled the catheter, which he holds lightly between the thumb and index and middle fingers of the right hand,

stations himself upon the patient's left side, as the most convenient in operating; he then takes the head of the penis between the fingers of the left hand, makes pressure upon it to open the meatus, into which the point of the instrument, with its concavity placed across the left groin, is introduced, and pressed along the urethra, taking care to

Fig. 587.



Mode of introducing the catheter.

keep the point in contact with its upper wall until it reaches the arch of the pubis, when the shaft of the instrument should be carried to the median line of the abdomen, and then depressed between the thighs, which movement will throw the point of the catheter into the bladder.

In this manner, with a little practice, the catheter can be introduced with neatness and rapidity.

Should this method fail, there is another plan, called by French surgeons the "tour de maitre," which will sometimes succeed; it is executed in the following manner: The patient may either assume the erect posture or lie down; the surgeon stands upon his right side, and passes the catheter with its open extremity looking downwards, into the urethra down to the triangular ligament; then by a lateral sweep through a semicircle he brings the shaft of the instrument to the median line of the abdomen; it is now depressed towards the thighs, to raise the point of the catheter into the bladder.

In either case, it will be known that the instrument has entered the bladder by the ceasing of the resistance to its progress, by the flow of urine, and by its beak rotating freely in the bladder when the shaft is rolled between the fingers.

If the silver catheter does not pass, a gum catheter may be tried, having impressed upon it the curve deemed by the surgeon most likely to insure its successful introduction. The wire stylet may be

partially withdrawn from the catheter in those cases where the prostate gland is enlarged, so that its point may rise above the obstruction and enter the bladder.

It will be always advisable in a healthy urethra to use a large instrument (No. 7 or 8, for instance), as it fills the canal fully, and is, therefore, less apt to catch in the folds of the mucous membrane. Should its point meet with any obstruction, the instrument may be slightly withdrawn, then again shoved forwards; or the penis may be stretched by drawing it along the shaft of the catheter, which will sometimes overcome the difficulty.

In old people the middle lobe of the prostate is often so hypertrophied as almost to close the urethra, as seen in Fig. 588. The open extremity of the catheter in such a case as this must be depressed more than would be required in operating upon a healthy urethra, so that the point of the instrument may pass above the obstruction; or perhaps a much more effectual plan will be to introduce into the rectum the left forefinger, with which the point of the instrument may be pressed upwards.

Fig. 588.

Hypertrophy of the middle lobe of the prostate gland.

The instrument should be longer than the one commonly employed, as the urethra is stretched by the enlarged prostate, and its curve must also be greater.

It should always be borne in mind in all cases offering obstruction to the free ingress of the catheter, that gentle and patient manipulation will accomplish much more securely, and certainly the object in view, than any forcible efforts, which are liable to lacerate the urethra and produce false passages; and when these occur in the membranous and prostatic portions of that canal, fatal suppuration may be engendered. If the catheter is to be retained in the bladder, it may be fastened with four threads to a ring prepared of metal or any convenient material, and large enough to encircle the penis in a state of erection so that no constriction can possibly happen; the ring is shoved up to the root of the penis and held in that position by threads or tapes passing upward and under the perineum to a belt around the waist.

Fig. 589.

Velpeau's method of fastening a catheter.

M. Velpeau sought to secure the same object with the arrangement seen in Fig. 589. A piece of linen is wrapped around the penis posterior to the glands, and four threads attached to the rings of the catheter are then wound about the linen and tied: this plan is not so good as the

previous one, inasmuch as it may produce constriction of the organ in case of erection.

Catheterism of the Female Urethra.—The female catheter is a silver tube seven or eight inches long, and slightly covered at its extremity. It may be introduced in the following manner: One hand is carried beneath the bedclothes, and the tip of the index finger seeks the orifice of the urethra below the junction of the nymphæ, which may be known by an impression communicated to the finger resembling somewhat that received by pressing it upon the end of the barrel of a key; then the catheter held in the other hand is conducted upon the index finger into the urethra.

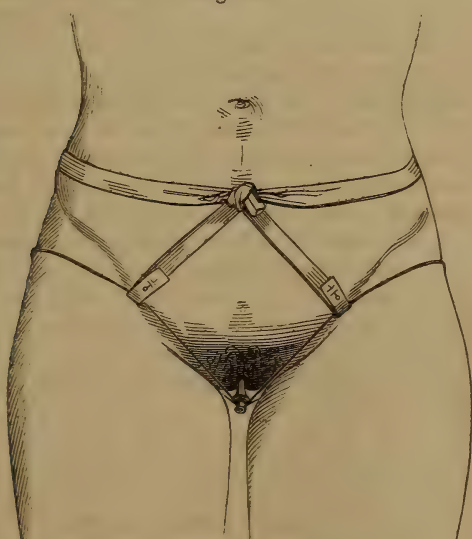
Another simple plan is to use one hand only, holding the catheter between the thumb and index finger in the manner seen in Fig. 590. The tip of the instrument rests beneath the point of the index finger which feels for the meatus, and, when found, the instrument may be easily slipped into it. It is simply necessary to hint, that no exposure of the patient's person is required in these manipulations.

Fig. 590.

Method of holding the female catheter.

In pregnant women, the uterus, in its development, draws up the urethra some distance, so that the meatus must be sought a little higher up than usual, behind the lower margin of the arch of the pubis; in such cases, the male catheter will, very often, be found the most convenient instrument.

Fig. 591.



Retentive bandage for the female catheter.

During the descent of the head of the child, the female urethra may be compressed, in which instance a flat catheter will answer better than one of a cylindrical form.

The neatest retentive bandage for the female catheter is arranged by attaching two threads to the rings of the instrument, and passing them around the upper part of the thighs, in which position they are sustained by two pieces of bandage extending from the centre of a belt around the waist to either thread, both in front and behind (Fig. 591).

CHAPTER XIV.

REMOVAL OF FOREIGN BODIES.

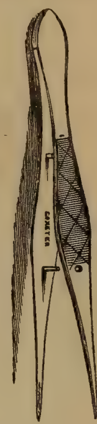
The removal of foreign bodies from the various parts of the body demands attentive consideration, as most cases of this kind are sudden emergencies, and call for prompt treatment, both to avoid the morbid conditions that their continual presence may occasion, and to calm the apprehension of the patient, which is usually considerable, even in the least serious cases. In certain instances the life of a person may be immediately involved by the presence of an extraneous body in the natural cavities.

Foreign Bodies in the Skin.—The most common objects that penetrate the skin are pins, needles, splinters of wood, fragments of stone, iron, or glass, and grains of gunpowder. The removal of rifle balls, fragments of shell, and pieces of clothing, comes naturally under the subject of gunshot wounds, and will therefore be considered under that head.

The hands of washerwomen and seamstresses, and the knees of children, are most frequently penetrated by pins and needles, which may be either partially or wholly buried beneath the skin. In the former case, they may easily be seized with the forceps and extracted; this cannot often be effected in the latter instance, for the object may be entirely concealed from the most scrutinizing examination, or at least can only be felt and moved beneath the skin with the fingers. Needles have remained imbedded in the tissues for years without causing the slightest trouble; in other instances they have produced soreness and stiffness of the muscles, and suppuration.

When the object can be felt, it should be removed by steadying it with the fingers, and making an incision down upon it, when, with the forceps, it may easily be seized and extracted. Exploratory incisions should never be made, as it can rarely happen that the body will be found. Mr. Erichsen recommends, for the purpose of extracting needles, thorns, splinters of wood, and other foreign bodies of small size and pointed shape, lying in narrow wounds, the forceps shown in Fig. 592. They have very fine, but strong and well-serrated points.

Fig. 592.



Erichsen's forceps for removing foreign bodies from the skin.

Sometimes a needle penetrates the knee-joint of children while romping upon the floor; and in two cases of the kind which have come under my notice, the inflammation excited by it resulted in anchylosis. The joint should be kept quiet for a few days, and recourse had to cold water-dressings, or other antiphlogistics, should inflammation arise. If the needle can be felt, it may be pressed as near the surface as possible, and removed through a valvular incision.

Workmen in wood often run splinters into the skin, or what is yet more painful, under the nail. They may be removed with the point of a needle or a bistoury, pressed beneath their projecting extremity, to lift them from their bed. Softened with the moisture of the parts in which they stick, splinters sometimes break in two, and leave no projecting end to be seized by the forceps; in such a case it will be necessary to run the point of a bistoury the whole length of the splinter, and then dislodge it with the forceps.

A large splinter, run beneath the nail, causes severe pain; and if it cannot be extracted with the forceps, the nail should be split up in the direction of the foreign body.

In blasting rock, fragments of stone may be driven into the tissues; the general rule in such cases is, to remove the objects immediately, if they can be felt, through an incision made upon them.

Grains of gunpowder, in explosions, sometimes stick into the skin of the face and hands. When the grains are not numerous, they may be taken out with the point of a needle; but in the majority of cases, neither the surgeon will feel inclined to undertake, nor the patient disposed to undergo, such a tedious operation. It has been recommended to apply a blister to the part for three or four hours, then to remove it and substitute a poultice; a more successful and agreeable plan, however, is to lay over the discolored surface, with a camel's-hair brush, a solution of corrosive sublimate in glycerine (gr. ij to f℥j). This solution does not dissolve the powder, but causes the little pits in which the grains are imbedded to suppurate and discharge them.

Gold and silver rings may constrict the fingers and require removal; if there is not much tumefaction it may be accomplished with a fine file; they may also be worked off if a piece of tape can be gotten beneath them, but the most ingenious plan is to convert them into an alloy with mercury, when they can be easily crushed beneath the fingers.

A case came under my notice where a boy having been punished for wetting his bed, and feeling his inability to prevent a recurrence of the involuntary discharge, tied a string about the penis. Inflammation and swelling succeeded; so as to hide it from view, and urination became impossible; the boy would give no information concerning the matter until the severe pain which it caused compelled him to divulge the secret.

The cord was snipped with the scissors, and all the bad symptoms disappeared.

Foreign Bodies in the Eye.—The surgeon has more frequently to deal with foreign bodies in the eye than in any of the other organs. They cause severe pain, intolerance of light, and a profuse secretion of tears; the conjunctiva becomes congested, and not uncommonly its enlarged vessels cause the patient to experience a sensation as if the foreign body was still in the eye, after its removal.

Cinders, spiculæ of iron, of steel, or stone, and sand, are the foreign objects that most often gain admission into the eye. When they simply repose upon the conjunctiva, the constant winking and flow of tears which they produce, with the rubbing which the patient usually inflicts upon the organ, not unfrequently carry away the offending cause. Should this not occur, the eye may be exposed to a good light, and while he holds the lids apart, the operator may remove the object with the point of a camel's-hair brush, the corner of a pocket handkerchief, the eye of a needle, or the bulbous extremity of a probe. To explore the inner surfaces of the eyelids they should be everted; the upper one, by drawing out the lid with the forefinger and thumb of the left hand, while pressure is made upon its upper surface with the pulp of the right index finger, or preferably the point of a probe or lead pencil; the lower lid is easily exposed by simply drawing it down upon the cheek.

The most difficult objects to remove are little bits of iron or steel when they become imbedded in the conjunctiva; the greatest gentleness and patience should be exercised in these cases lest irreparable injury be done to the structure of the eye.

The best plan is, after securing the benefit of a good light, to place the point of a cataract-needle (or a common one will do very well) beneath the bit of metal and lift it from its bed. After the removal of the intruder, cold water applications will be found both agreeable to the sensations of the patient and beneficial in checking inflammatory action. A drop of glycerine placed between the lids will also produce an agreeable sensation of relief.

Foreign Bodies in the Ear.—Beans, peas, beads, small pebbles, insects, particularly the earwig, and similar bodies sometimes gain admission into the external meatus either accidentally or intentionally. They occasionally produce intense pain, especially those that, being absorbent and swelling, distend the auditory canal. The cerumen may also collect in hard pellets and occasion deafness, singing in the ears, and dizziness.

In children, the irritation from a foreign body in the ear may be so great as to produce convulsions.

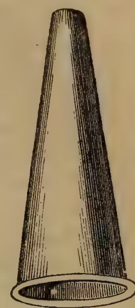
The ear in these cases should be carefully examined by placing the patient's head in such a position that the rays of a strong light may be concentrated in the meatus, which should be straightened as much as possible by drawing the auricle upwards and backwards. Or a speculum may be used, that of Mr. Toynbee, of Dublin, is the best (Fig. 593). Wilde's instrument, seen in Fig. 594, sometimes

employed, is conical in shape and causes a good deal of pain when the lining membrane of the meatus is much swollen and tender. I have been in the habit, for several years, of using the illuminating otoscope, seen in Fig. 595, which I prefer to all others; for with a little practice, the meatus and membrane of the tympanum may both be beautifully illuminated, and I have succeeded in discovering a foreign body, in this manner, when other instruments have failed me. In using the otoscope, the tube is introduced into the meatus with the funnel, *b*, of the instrument looking backwards; in front of the latter a steady flame is put so that the rays of light may strike upon the polished metal mirror, *c*, which throws the rays in the direction of *d e*, into the meatus; the eye of the

Fig. 593.

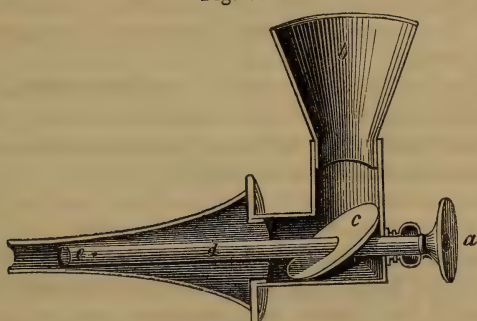
Toynbee's ear speculum.

Fig. 594.



Wilde's ear speculum.

Fig. 595.

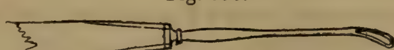


Otoscope.

observer placed at *a* can now see the membrane of the tympanum illuminated through the tube *a d e*, which is movable, to enable the surgeon to adjust the focus of a convex lens located at *e*.

The simplest and at the same time most efficient way of dislodging an extraneous object in the meatus is by throwing a stream of water into it in the manner described at page 108.

Fig. 596.

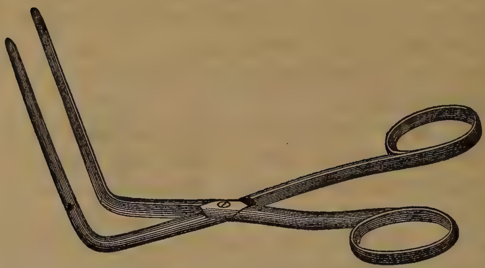


Instrument for removing foreign bodies from the ear.

Should this not succeed, an eyed probe may be bent a little at its extremity, and used as a hook to draw the body forwards; a curette will sometimes answer the same purpose (Fig. 596).

Mr. Toynbee recommends a pair of rectangular forceps, which will enable the surgeon to look into the auditory canal while the instrument is being used in seizing the object (Fig. 597).

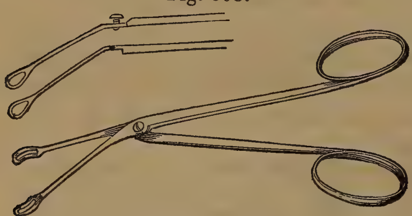
Fig. 597.



Toynbee's forceps for removing foreign bodies from the meatus.

Dr. Hewson, of Philadelphia, has constructed a pair of forceps bent at their articulation; the blades are separable from each other, and form at their extremities little oval rings, which are well adapted for seizing hold of rounded objects; a single blade may be used, if necessary, as a lever.

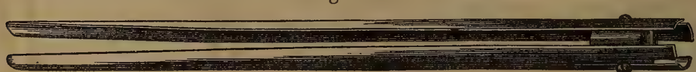
Fig. 598.



Hewson's forceps.

Dr. Corse, of the same city, devised for this purpose the instrument represented in the annexed wood-cut (Fig. 599), and described by him in the *American Journal of the Medical Sciences* for October, 1858. It consists of two equal sections of a cylinder, rounded at one end, and fenestrated at the other; these are connected together by a small piece of metal bearing two little pins upon either side, which slide into the fenestra. By this arrangement, the blades can be introduced into the meatus singly, and then united by the pins.

Fig. 599.



Corse's instrument for removing foreign bodies from the ear.

The canula-forceps may also be used for seizing small bodies, but they are not nearly so efficient or manageable as the foregoing instruments.

Insects may be suffocated by filling the meatus with sweet oil or glycerine, and then washed out with the syringe.

Concreted cerumen, as stated above, sometimes causes deafness and irritation of the auditory canal: the plan to follow in this case is first to soften the wax with a solution of the carbonate of soda in water (gr. x to f℥j), and then to wash it out with warm water or to scoop it out with a curette.

Should the removal of any of the foreign bodies be likely to cause much suffering to the patient, the administration of chloroform will be requisite.

The after-treatment will consist in combating local inflammation by the application of leeches first, and then emollient dressings.

Foreign Bodies in the Nose.—Buttons, beans, or beads are sometimes thrust into the nose by children in their play; they often cause considerable irritation and inflammation of the mucous membrane, which swells up, and closes the nares so as to give a good deal of trouble in removing them.

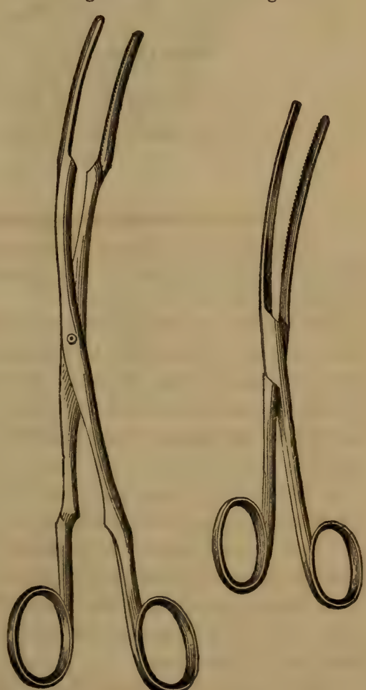
The eye-probe, bent at its point, may be used as a hook to draw out the intruder, or a canula with a wire loop running through it.

Sometimes the injection of water, either from before backwards or the reverse, will succeed; in the former case the object will of course be carried into the pharynx, from which it can readily be expelled by the voluntary efforts of the patient.

Causing the patient to sneeze violently by snuff or other sternutatories, while the mouth is held shut, may also dislodge the foreign body.

Foreign Bodies in the Pharynx and Œsophagus.—Small objects, such as bristles, needles, pins, buttons, coins, fragments of fish or chicken bone, sometimes lodge about the base of the tongue, in the lower part of the pharynx or œsophagus, causing an uneasy sensation in the throat and a constant disposition to hawk and cough. Should the body be larger, and become impacted behind the larynx, as occurs from a morsel of meat being arrested at this point of the œsophagus, the most distressing symptoms of suffocation are produced, and death may result from suffocation.

Fig. 600. Fig. 601.



Bond's gullet forceps.

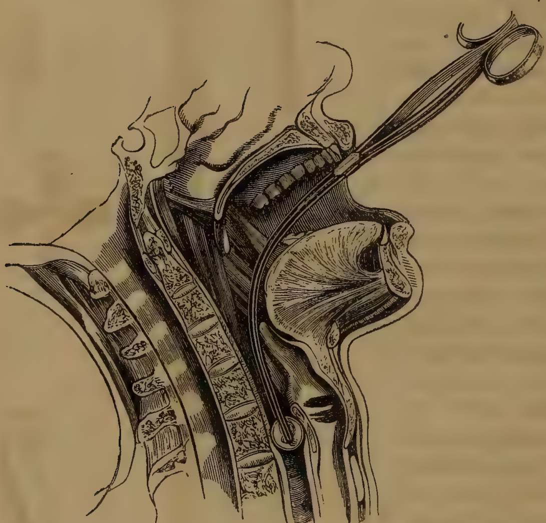
Prompt action is required in the treatment of these cases; the surgeon should first throw the patient's head back, and pass his index finger into the pharynx; he may succeed in this manner either in fishing out the object, or shoving it beyond the larynx if suffocation is threatened; though it will be better, should delay be possible, and the object indigestible, irregular in shape, or likely to injure the mucous membrane of the stomach, to remove it with a pair of forceps. Those most likely to be at hand will be the dressing forceps, which will answer very well if the object is not too far down; the best instruments, however, for the purpose are the forceps seen in Figs. 600 and 601, devised by Dr. Bond, of Philadelphia; in one pair the blades are curved at right angles with the rivet, and in the other in the same plane with it; their inner margins are bevelled outwards, leaving a line of serration only at their centres; an arrangement that

will prevent the mucous membrane of the gullet being pinched between them when the forceps are closed.

In using this instrument the head of the patient is thrown back, and the blades of the forceps glided over the tongue into the œsophagus, as seen in Fig. 602.

It may be observed that the constant motion of the tongue will sometimes render these manipulations about the throat troublesome;

Fig. 602.



Mode of introducing the forceps into the gullet.

Fig. 603.

Bond's gullet hook.

this may be obviated in a great measure by letting the patient inhale a few whiffs of chloroform.

If the finger should not be long enough to shove the object beyond the larynx, a probang will enable the surgeon to accomplish this, and if necessary press it also into the stomach.

Dr. Bond contrived a hook made of copper wire silvered, or silver wire, of the shape presented in Fig. 603, for the purpose of removing pins or coins; it is to be passed into the œsophagus beyond the object, and then drawn up to catch it in the hook.

A useful instrument for the removal of needles, bristles, and similar objects, is shown in Fig. 604; it is composed of a metallic stem and sheath mounted with bristles, connected with them in such a manner that by moving the stem the bristles are made to expand laterally, and fill up the œsophagus; and when the instrument is withdrawn it sweeps, so to speak, the whole length of that canal.

Prof. Gross recommends an excellent instrument for extracting foreign bodies from the gullet. It consists, as seen in Fig. 605, of a metallic tube fifteen inches long, and slightly curved; through this runs a slender rod, bearing at its extremity four little wing-like

Fig. 604.

Instrument for removing needles from gullet.

Fig. 605.

Gross's instrument for removing foreign bodies from the œsophagus.

apparatus, which may be open or shut at pleasure by turning the handle of the instrument.

Dr. Bright, of Kentucky, had recourse to an ingenious expedient for removing a fish-hook attached to a cord, that had been swallowed. He perforated a leaden ball with a hole; through this he passed the string connected with the hook, against which the ball was pressed. In this manner the point of the hook was guarded, while the surgeon took hold of the cord and withdrew the ball and hook together safely.

An emetic of mustard or the sulphate of zinc will often succeed in dislodging the extraneous object from the gullet; it should be assisted by drinking freely of water or some demulcent fluid.

Foreign bodies that have entered the œsophagus may remain in that canal without causing any trouble for a long time, or they may escape into the blood-vessels, or other organs of the thoracic cavity, and produce fatal hemorrhage, or inflammation and suppuration. In other cases the object slips into the stomach, remains there for a longer or shorter time, and is finally voided by stool; or the intestines may be perforated, and the object ultimately emerge from the skin.

The after-treatment requires the use of emollient fluids, if the foreign bodies produce irritation of the œsophageal or gastric mucous membrane.

Removal of Foreign Bodies from the Larynx and Trachea.—From carelessness in holding small objects in the mouth, they are sometimes accidentally drawn into the larynx and trachea during the inspiratory act, giving rise to a most distressing condition, which calls often for immediate surgical interference to save life.

The articles that commonly intrude themselves in this manner are coins; seeds of certain fruits, as the cherry and plum; grains of corn

and coffee; beans; bits of meat; buttons; pebbles; cockle-burs; teeth in several recorded cases; and a number of other substances. According to their size, shape, weight, and the condition of their surface as to smoothness, they occupy different portions of the air-passages: those that are light, sharp-pointed, or covered with projecting points, may stick at the superior orifice of the larynx, or catch when they arrive at its ventricles; while those that are round, heavy, and smooth, will generally glide through the larynx and trachea, and lodge in the bronchi; the right one, from its size and position, being most frequently penetrated. The object may be fixed at any point, or move up and down through the whole length of the larynx and trachea.

The results which most commonly follow from the retention of a foreign substance in the air-passages are inflammation of the mucous membrane lining them; pneumonia of a portion or the entire of one lung, corresponding with the bronchi in which the body is located; phthisis; pulmonary emphysema; and lastly emaciation.

The symptoms produced are those characteristic of obstructed respiration; the patient coughs violently, gasps for breath, seizes his throat as if to tear away some obstruction there; stares about him wildly; and not unfrequently falls down unconscious. The face becomes livid and swollen; and there is more or less expectoration of mucous matter, occasionally accompanied with blood, during the fits of coughing. This paroxysm lasts from a few seconds to several minutes, or even longer, when the breathing becomes more tranquil and the severity of the symptoms diminish. Thus the patient will be harassed with alternate paroxysms of these distressing symptoms and periods of abatement, until he either dies suffocated, or worn out by consecutive disease of the thoracic viscera. Cases have been observed in which none of the above phenomena were present, or, if so, in a very mild degree.

The cough is at times of a spasmodic character, resembling that of croup, so as to render the diagnosis of the case difficult; other of the symptoms have also been so simulated by those of catarrh, pneumonia, and phthisis, as to embarrass the judgment of the practitioner.

An accurate inquiry into the history of the case, with a careful physical examination of the chest, is the only means of arriving at a correct conclusion in such instances.

When the diagnosis has been clearly made out, an effort should be made by the surgeon to dislodge the foreign body from the air-passages by placing the patient in such a position that the head and chest may be lower than the rest of the body, when the back should be struck with quick blows with the hand; in this manner the foreign substance may be started, so that it will escape through the glottis, as was successfully done in the well-known case of the English engineer, Brunel, recorded by Sir B. Brodie; a half sovereign had accidentally slipped into this gentleman's trachea while amusing some children.

The foreign body will in some cases be expelled by violent efforts at coughing.

Should this process fail, nothing remains but to perform the opera-

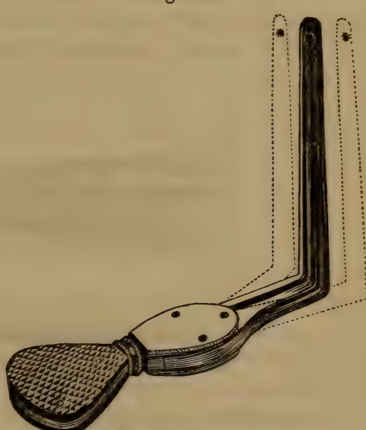
tion of laryngotomy or tracheotomy, and to extract the foreign body with properly constructed forceps.

After the patient has been relieved from the presence of the object in the windpipe, he is not always secure of his life, inasmuch as the inflammatory condition of the mucous membrane of the air-passages and lungs excited by it, may lead to a fatal termination. These complications should engage the earnest attention of the medical attendant, that they may be combated by appropriate measures.

Removal of Foreign Bodies from the Urethra and Bladder.—The urethra may become obstructed by the presence in it of fragments of calculi, clots of blood, concrete mucus, or fragments of bougies which have broken off the instrument during its introduction. In other cases, persons have designedly put into the canal sticks, slate-pencils, or hair-pins. They may occupy any portion of the urethra; and give rise to retention, local inflammation, and pain.

When near the orifice, their removal may be effected by seizing them in the jaws of a pair of finely-pointed forceps (Fig. 611), or with a bent probe, curette, or a loop of fine wire. If further in, they may occasionally be pressed towards the meatus, and removed in the manner above mentioned; or, if this cannot be done, perhaps a large-sized catheter introduced down to the obstruction, so as to dilate the urethra and permit the foreign body to move forwards by the pressure of the urine behind, may succeed.

Fig. 606.

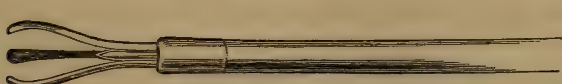


Weiss's urethral dilator.

Mr. Weiss, of London, has invented an instrument for dilating the urethra, shown in the annexed wood-cut (Fig. 606); it consists simply of a metallic stem divided into two equal segments, and capable of being expanded to the required extent, so that the points of the forceps may be introduced.

Many ingenious urethral forceps have been devised for the purpose of seizing hold of the intruding substance and removing it. Fig. 607 shows an instrument composed

Fig. 607.



Urethral forceps.

of three slender branches, which are inclosed in a canula, and when brought down to the object, may be protruded to grapple it.

Weiss's forceps consist, as seen in Fig. 608, of two blades, B, inclosed

in the canula A, for seizing the fragment of calculus, while it may be reduced to powder by the drill working between them.

Fig. 608.

Weiss's forceps.

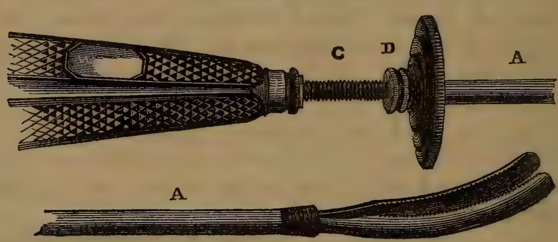
A convenient instrument will be found in the scoop-pointed canula with a narrow tongue moved by a central stem, as seen in Fig. 609,

Fig. 609.

Instrument for removing foreign bodies from the urethra.

or the double-bladed forceps delineated in Fig. 610, which consists of two narrow blades concealed in the canula (A), and capable of being expanded by being thrust forwards, and, when the foreign substance

Fig. 610.



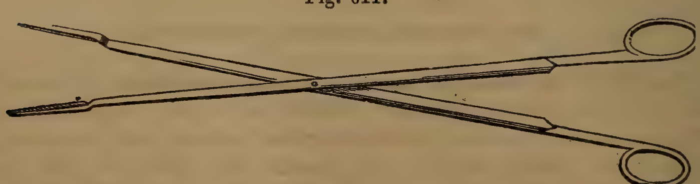
Double-bladed urethral forceps.

is grappled, closed again by simply shoving the canula upon them; the screw D regulates the distance between the blades.

In manipulating with these instruments, the finger should be placed upon the foreign body, to prevent its moving while it is being seized.

Should the surgeon fail with the forceps, nothing remains but to

Fig. 611.



Urethral forceps.

cut down upon the urethra and remove the obstructing substance; and, if it is possible, this should be pressed into the membranous

portion of the canal, and the incision made upon the perineum, for the reason that wounds of the membranous urethra heal with much greater celerity and certainty than those anterior to the bulb.

The female urethra is short and very dilatable, and little difficulty will therefore be encountered in removing extraneous substances from it; for this purpose the delicate pair of forceps seen in Fig. 611 will answer very well.

Removal of Foreign Bodies from the Vagina.—Large objects may be introduced into the vagina, either by the patient herself, under some unnatural excitement, or, criminally, by another person; or certain instruments, such as pessaries, that have been employed in the treatment of uterine disease, are permitted to remain in the canal until they produce great derangements of health, and, in some cases, ulceration into the rectum or bladder. M. Cloquet reports a case in which a cork pessary remained in the vagina ten years.

For the removal of these objects, great delicacy of manipulation is required. The vagina should be first syringed, to clear away all adhering mucosities; a speculum is then introduced, and its walls dilated; when the object is thus brought into view, it may be seized with the forceps and withdrawn. If the body is large and impacted, it may become necessary to divide the sphincter.

Removal of Foreign Bodies from the Rectum.—Foreign substances are sometimes introduced into the rectum by design, such as pebbles, pieces of wood, vials, and bougies; or they are ingested, and become entangled in the folds of mucous membrane just within the sphincter; of these the most frequent are the seeds of fruits, such as cherries, grapes, &c. In old people, especially females, the feces become impacted in the rectum, even in some cases as high as the sigmoid flexure, giving rise to derangements of digestion, loss of sleep, pain and a sensation of fulness in the bowel; the patient passes a thin mucoid fluid, often tinged with blood, so as to lead the medical attendant to suspect the presence of dysentery.

The removal of the feces is effected by breaking down the hardened mass with the finger, well oiled, and passed into the gut; should this not be long enough to reach, the handle of a tablespoon may be used, or the ordinary scoop employed in lithotomy (Fig. 612) to clear

Fig. 612.

Scoop for removing foreign bodies from the rectum.

the bladder of the débris of calculi. A copious stream of warm water must also be thrown into the bowel, with the India-rubber ball syringe attached to a long muzzle, or the tube of the stomach-pump, to soften the feces, which will render the operation less painful. When small objects are present, they may be seized with the forceps and withdrawn; and larger ones may be crushed with a strong instrument and removed piecemeal, as was done by Dr. Parker, of

Canton, in the case of a Chinaman, into whose rectum a glass goblet had been thrust.

In the case recorded by Marcetti, of a courtesan who had the butt-end of a pig's tail, rendered rough by having its bristles cut off, forced into her rectum by some students, the removal was accomplished by slipping a piece of reed over the pig's tail, to which a cord was attached, so as to protect the rectal mucous membrane. In the same manner any rough object may be extracted through a large metallic tube.

CHAPTER XV.

ON THE MODES OF ARRESTING HEMORRHAGE.

Hemorrhage, whether proceeding from accidental wounds or from those following the employment of the surgeon's knife—or whether it rushes in angry torrents from any part of the body in consequence of disease, is always a serious misfortune, and often involves the safety of the patient's life by its quantity or continuance.

In that variety of hemorrhage arising from the first two causes, which principally concerns us here, the blood may issue from the capillaries, veins, or arteries.

Capillary hemorrhage rarely takes place to any considerable extent unless it be in those persons laboring under the hemorrhagic diathesis, or in whom the blood has undergone morbid changes, and the constitutional powers are broken down by great fatigue, improper or insufficient food, or other causes.

Venous hemorrhage, when from small vessels, usually quickly ceases by the collapse of their walls; if the veins are larger, or so connected with the surrounding tissues that their walls cannot fall together, the hemorrhage will take place freely; the blood, which is of a dark color, runs from the wound in a continuous stream, and is increased in quantity by a ligature placed around the limb above the part injured; the lower extremity of the vein always supplying the blood, except in a few cases where the vessel is too large to be closed completely by the valves with which it is provided; in this case the blood will flow from both ends of the vein.

Arterial hemorrhage, as its name implies, springs from the arteries, and is the variety which the surgeon is most frequently called upon to control. The vessels may be partially or completely divided, or the wound may be transverse or longitudinal to their axis. The blood escapes *per saltum,* as it is designated—that is, in jets isochronous with the contractions of the heart; and it is florid, and more or less frothy. Pressure in the course of the vessel above the wound, diminishes or arrests it. In deep or sinuous wounds the blood may simply well up, instead of escaping *per saltum,* as it usually does, in

consequence of its force being broken by striking against their walls; but the red color remains, to distinguish it from venous blood.

In wounds of the large arteries of the limbs, the condition of the circulation in the latter will depend upon the point at which the injury is inflicted. If the trunk is cut through high up, above the large anastomotic branches, pulsation cannot be felt in the vessels below; while, on the other hand, if these branches are above the wound, this pulsation will be only diminished. In the former case, the upper extremity of the artery alone pours out blood; and in the latter, both extremities bleed. The blood usually escapes from the lower orifice in a continuous stream, as in the veins; but if the circulation is rapid, and the anastomosis undisturbed, the stream may leap forth *per saltum.*

When an artery of large size is cut in two, the blood gushes out rapidly, and, if not instantly checked, the patient dies in a few seconds. The hemorrhage from smaller arteries is less copious, and after a certain quantity has escaped, the patient faints, and thereby the force of the circulation is diminished; the ends of the severed artery retreat amidst the surrounding cellular tissue; and they also contract so as to bring the margins of the divided inner coats in contact, and diminishing the canal immediately above. The blood in the vessel coagulates as high up as the first collateral branch above, forming a sort of internal plug, while an effusion of plastic matter at the orifice of the vessel serves the purpose of an external plug. By the combined action of these conditions, the hemorrhage is naturally arrested, and no more bleeding occurs in some cases; in other instances as soon as reaction is established, the hemorrhage is renewed in consequence of the increased force of the circulation forcing the clots from the mouth of the artery. This may occur again and again until the vessel is tied or the patient dies exhausted. This is called *intermediary hemorrhage.* Should the vessel be partially divided—say a quarter of its circumference—the blood will escape *per saltum,* but not so freely as in the former case, because a part of it keeps on in its natural course. In this case, if pressure is made over the injured part, the wound in the artery may heal up. If half or three-fourths of the circumference be divided, no contraction of the wounded artery can take place, unless the tongue of tissue remaining is destroyed by ulceration or the knife; and the bleeding will necessarily continue indefinitely. Hence it is that wounds of arteries of this character are more serious than those in which they are cut in two, and the bleeding from them is more difficult to stanch.

When an artery is violently twisted or torn, there is usually little or no hemorrhage, as its internal coats are lacerated and then promptly retract.

After an artery has been secured and the bleeding arrested until the lapse of some time, and then the hemorrhage is renewed, it is said to be *secondary.* It may occur in any sort of wound, and is most commonly observed between the fifth and twenty-fifth days. The hemorrhage depends upon several causes, among which may be mentioned sudden movements of the wounded parts, or violent muscular

exertion; ulceration of the artery; sloughing; the hemorrhagic diathesis, a peculiar condition sometimes observed to be hereditary; or by perforation of the vessel by a spicula of bone. In one case it resulted from the excitement of coitus. As in primary hemorrhage, both ends of the artery should also be tied in *secondary hemorrhage.*

The methods that have been suggested from time to time for arresting hemorrhage are quite numerous, but we shall only consider those that are actually employed at the present day.

1. STYPTICS are of two kinds—those acting mechanically, and those acting chemically; among the former are classed, scraped lint, fur, amadou, spider's web, and various absorbent powders, such as gum Arabic, &c.; among the chemical styptics we find the various astringents—tannin, galls; matico; powdered alum, or a saturated solution of that substance; sulphates of iron, copper, and zinc; creasote in solution; persulphate of iron; nitrate of silver, and many others. The chemical styptics act by constringing the tissues, and promoting the coagulation of blood; they can only be depended on in hemorrhage proceeding from the capillaries and smallest arteries.

The powerful styptic of Pagliari is prepared in the following manner: Eight ounces of tincture of benzoin, one pound of alum, and ten pounds of water are boiled together for six hours in a glazed earthen vessel, the vaporized water being constantly replaced by hot water, so as not to interrupt the ebullition, and the resinous mass kept stirred round. The fluid is then filtered, and should be kept in stoppered bottles.

The coagulative power of this fluid is remarkable, every drop of it poured into a glass containing human blood produces an instantaneous magma; and, by increasing the proportion of the styptic to the quantity of blood, a dense, homogeneous, blackish mass results.

M. Maisonneuve, in operations attended with much hemorrhage, uses the perchloride of iron applied to each vessel by a pledget of charpie which is allowed to attach itself to the wound. The fluid forms a brown eschar which separates from the wound in from twenty to thirty days, leaving a healthy granulating surface beneath.

2. COLD.—In bleeding from the small vessels of the skin and capillaries, the simple exposure of the wound to the air suffices often to check it; cold water, and evaporating solutions applied with cloths will be found more efficient still; ice, powdered and inclosed in oiled silk or a bladder, laid over the part, is also a powerful hemostatic; or a lump of ice may be put right upon the wound. The action of cold as a styptic is similar to that of the astringents, and cannot be relied upon in bleeding from large vessels.

3. ACTUAL CAUTERY acts mechanically in sealing up the orifices of the bloodvessels, and the hemorrhage is liable to be renewed when the eschars separate; the iron should only be brought to a *black heat,* so that it may also excite the adhesive inflammation in the parts as well as sear them. In secondary hemorrhage from a sloughing stump, the actual cautery will be found a valuable resort.

4. PRESSURE is often employed to check hemorrhage. Sometimes it is continued until the bleeding vessels are firmly sealed up, so that

upon its removal the blood will not again flow; or the pressure may be a temporary expedient until other more reliable means are practised to secure the bloodvessel. The pressure is exercised either with the fingers or with specially constructed instruments called tourniquets and *compressors*. It is most efficient and certain when the artery can be pinched against a solid resisting surface, as bone. In this manner the facial, temporal, and occipital arteries can be compressed against the bone beneath. The flow of blood through the carotid may be arrested by making pressure upon it with the fingers against the cervical vertebræ; the artery is easily felt at the inner margin of the sterno-cleido-mastoid muscle, and the pressure will be efficient anywhere upon its course between the hyoid bone and the transverse process of the sixth cervical vertebra; below this last point the vessel is too deep to be acted upon with any certainty. It is remarkable, considering the anatomical relations of the carotid, how long pressure with the fingers can be efficiently sustained without inconveniencing the patient to any great extent. The subclavian artery may be compressed over the first rib either with the thumb or with the padded ring of a key placed just above the clavicle. In a case of a gunshot wound of this vessel, I packed the wound with pieces of sponge until they projected above the surface; a compress was put on the sponge, and the whole dressing sustained by a tourniquet passing around the shoulder and the corresponding elbow; though this mode of arresting hemorrhage is very uncertain.

The axillary artery passing through the axilla may be compressed with the fingers against the head of the humerus.

The brachial is comparatively superficial, and may be found running along the inner borders of the coraco-brachialis and biceps muscles. It may be compressed at any part of its course against the humerus, as shown in Fig. 613. The radial and ulna arteries may be easily felt at the lower thirds, and the flow of blood arrested in them by compression against the bones beneath. This plan is sometimes pursued in wounds of the palmar arch, but is far from satisfactory. In one case I was called upon to amputate the forearm for gangrene, where a practitioner had applied compression to the radial and ulnar arteries for palmar hemorrhage. In another, the bleeding continued in spite of the most persevering compression, to such an extent as to jeopardize the patient's life. An incision was immediately made, and the artery ligated. If compression is employed at all in these cases, the best mode of effecting it is by stuffing the wound in the palm full of lint in the form of a graduated compress, until it

Fig. 613.

Mode of compressing the brachial artery.

projects above the surface. Place a second compress upon the back of the hand; over each compress lay a small stick transversely; then bind the extremities of the sticks together.

Fig. 614.

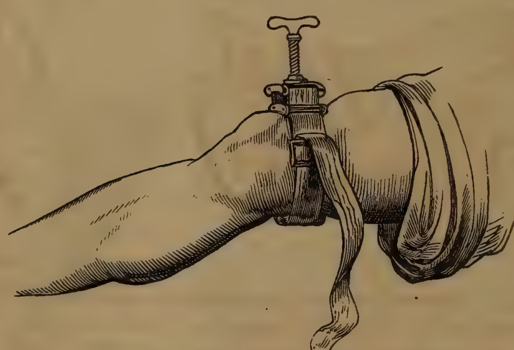
Mode of compressing the femoral artery.

In profuse bleeding from wounds of the iliac arteries, and from the uterus, compression may be made for a short time upon the abdominal artery. The patient should be placed horizontally, with his shoulders elevated, and the thighs drawn up to relax the abdominal muscles as much as possible in this position. If the person is moderately thin, the circulation through the vessel may be arrested by pressing it against the lumbar vertebræ. The compression should be brought to bear upon a point in the median line just above the umbilicus. The external iliac artery is also difficult to compress; but it may be accomplished with the fingers by pressing from before backwards, and from within outwards, directly over the linea ilio-pectinea.

With the thumbs laid one upon the other, as seen in Fig. 614, over the femoral artery as it passes over the pubis, the current of blood through it may be at once controlled.

Compression upon the popliteal artery is made with a tourniquet, in the manner seen in Fig. 615, the vessel being pressed by the pad

Fig. 615.



Mode of compressing the popliteal artery with a tourniquet.

of that instrument directly against the intertrochanteric surface of the femur.

The posterior and anterior tibial may be compressed in the lower

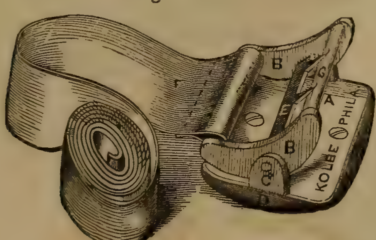
parts of their courses, the former behind the inner malleolus, and the latter part upon the top of the foot, at the inner side of the tendon of the tibialis anticus.

In making pressure with the hands we either employ the thumbs in the manner we have already described, or the points of the fingers placed close together in a row. Just that amount of force should be used necessary to arrest the circulation, and no more, inasmuch as anything in excess of this, without doing any good, only serves to exhaust the person making the compression. When one hand is tired, the other may be substituted for it, or the fingers over the vessel may be reinforced by those of the other hand.

This mode of arresting hemorrhage with the fingers is had recourse to usually in emergencies, until other measures can be taken to check the blood permanently, and also in amputations at the shoulder and hip-joint. In operations below these joints, and where the compression is required to be kept up with greater certainty and for a longer period, tourniquets and compressors are employed. A tourniquet may be extemporized at any moment with a cravat, piece of rope, strips of any sort of cloth, or a bunch of grass, or fine roots twisted into a cord. If required, direct pressure may be sought to bear upon the bleeding artery by slipping a gravel, lump of earth, piece of wood, or any similar object beneath the tourniquet.

The apparatus known under the name of the "Spanish windlass" (Fig. 616) is also a simple and efficient contrivance; it consists of a compress placed over the artery, and fixed by the body of a cravat, the ends of which are knotted upon the opposite side; beneath the knot a piece of pasteboard, or other material, is laid, to prevent the skin

Fig. 617.



Field tourniquet.

Fig. 616.

Spanish windlass.

being painfully pinched when the cravat is twisted by the short stick introduced under it. The *field tourniquet,* now supplied to the medical officers of the army and navy, consists of a pad (D), supported upon the convexity of a sort of cradle (B) by the upright (C). To one side of the cradle the ordinary lac of webbing (F) is attached, while the other side (G) forms, with the cross-piece (E) the buckle. From the peculiarity of the connections of the pad, it holds its position upon the artery remarkably well.

The form of tourniquet most commonly used in this country is that of J. L. Petit, seen in Fig. 618. A strong webbing lac is attached to a metallic frame consisting of two parts, moving to and from each other by means of a screw; the lac is buckled around the limb, and the required degree of constriction is effected with the screw. Before the apparatus is put on, it is important to see that it is in proper order, and that there is no chance of any of its parts giving way during the operation; a roller or thick compress should be put over the artery beneath the band, and the tourniquet placed upon the opposite side of the limb; or sometimes this arrangement may be conveniently reversed—that is, the tourniquet placed upon the roller over the artery.

Fig. 618.

Petit's tourniquet.

The point at which the instrument must be applied will vary with the requirements of each particular case. Fig. 619 shows the brachial artery compressed high up towards the axilla; Fig. 620 presents an illustration of the

Fig. 619.

Tourniquet applied to the brachial artery.

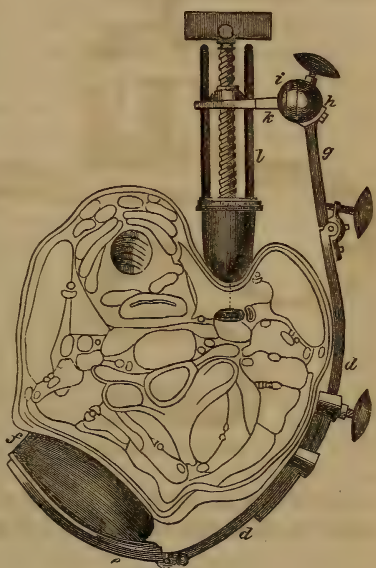
Fig. 620.

Tourniquet applied to the femoral artery.

femoral compressed with the tourniquet just below Poupart's ligament.

To avoid the objectionable feature in the foregoing apparatus—circular constriction of the limb—Dupuytren devised a *compressor* which has but two points of bearing, upon opposite sides of the limb. It is composed of two curved steel strips half an inch broad, sliding upon each other, and permitting the arc to be increased or diminished at pleasure. Each of the strips bears a pad at its free extremity; one of the pads is movable, the other fixed, though both may be bent upon the steel strips at any angle by means of a joint controlled by a thumb-screw. In applying the instrument, the larger or fixed pad is placed upon that side of the limb opposite the artery upon which the small pad is made to act by the screw.

Fig. 621.



Dupuytren's compressor.

A less complicated and more convenient instrument is the compressor of Prof. Gross, of Philadelphia, who thus describes its advantages and construction: "It possesses several decided advantages over the ordinary tourniquet; first, in the facility of its application; secondly, in the amount of pressure which it is capable of exerting; thirdly, in its ready adaptation to limbs of different dimensions; fourthly, in the circumstance that it makes pressure only at two points—that is, over the artery and at the spot immediately opposite to the artery; and, lastly, the facility with which it may be slackened or removed at any stage of the operation. With a little

Fig. 622.

Gross's arterial compressor.

modification, the instrument may readily be adapted to the femoral artery as it emerges from beneath Poupart's ligament, or even to the

external iliac just above this ligament, in amputation at the hip-joint, and also to the axillary artery, in disarticulation of the shoulder-joint. By a reference to the cut, it will be seen that the instrument is composed of two blades, differing in the degree of their curvatures, united by a screw, and regulated by a ratchet. Each short blade is provided with a pad capable of being worked by a screw, and designed to rest upon the artery which it is intended to compress. By this arrangement two tourniquets are produced: a large one for the thigh, and a small one for the arm, or the thigh of a small subject."

Compression is occasionally made over the whole extent of the vessel by compresses laid carefully upon its course above the wound, and maintained by a roller bandage exercising uniform and regular action upon the limb from its extremity to its junction with the body.

This method is useful in assisting other hemostatic measures, but should never be depended upon alone as a definitive dressing.

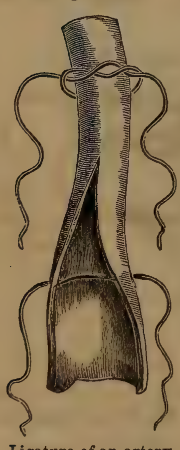
Direct pressure upon the mouth of the bleeding vessels by plugging the wounds from which the blood issues is sometimes employed, as in the hemorrhage following the operation of lithotomy. When the blood issues from the vessels of a bone, and other means fail to check it, the orifices upon the bony surface may be plugged with wax or a piece of soft wood; fracture of the skull rupturing the middle artery of the brain may require the same expedient to arrest the bleeding.

Direct pressure is, however, painful, excites inflammation, and is fatal to union by first intention, and is therefore not to be adopted, either provisionally or as an auxiliary to other hemostatic measures when the latter will succeed alone. Generally the compresses are saturated with some astringent before their application.

Direct pressure once established upon a bleeding artery, the dressings should not be disturbed, as long as the hemorrhage is checked, for seven or fourteen days, according to the size of the vessel.

The ligature revived by Ambrose Paré as a substitute for the cautery iron is the most efficacious of all the hemostatic means employed by surgeons. It has been prepared from a variety of materials, silk and linen threads, metallic wires, especially those of silver, several sorts of animal substances, as catgut, deerskin, etc.; but the material now chosen as possessing the most advantages is well-waxed round silk thread, known under the name of saddler's silk.

Fig. 623.



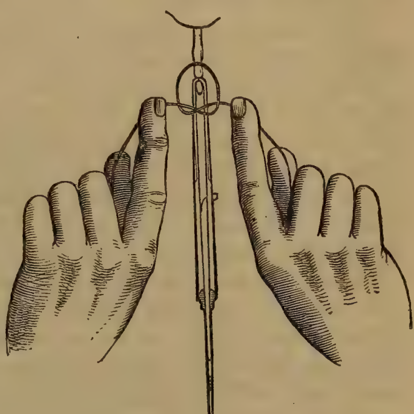
Ligature of an artery.

When a thread is tied around an artery, it divides the inner and middle coats of the vessel, as seen in Fig. 623, leaving the external cellular coat included in the loop. The blood in the artery between the point where the ligature is tied and the first collateral branch above, coagulates, plastic matter is poured out, and in course of time the clot unites with the inner and middle coats, and finally this portion of the vessel becomes converted into a fibrous cord. The ligature by its pressure causes ulceration of the cellular coat, and comes away, in

from five to twenty-five days, sooner or later, according to the size of the artery. We have stated that the rounded silk ligature is generally chosen because it makes a clean division of the two interior coats of the artery; but in those cases in which the vessel is diseased and brittle the ligature must be larger, and the knot not tied so tight, otherwise it will cut entirely through. Some surgeons, under these circumstances, have preferred to use flat threads, and even to place a little compress between the ligature and the artery; the latter plan is objectionable, and has justly been abandoned.

When the bleeding vessels are divided completely, as in amputation, their mouths may be drawn out a little with a tenaculum or the points of the forceps, the former instrument being more convenient in seizing smaller vessels; the adjoining nerves and tissues are then to be separated as far possible, and the ligatures applied.

Fig. 624.

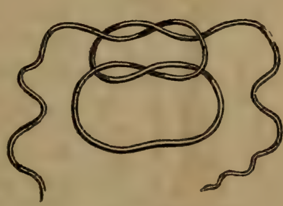


Mode of tying a ligature.

Where the artery lies deep in a wound, the ligature is carried around it with the instrument called an aneurism-needle, which has already been described at page 43. The vessel should be first laid bare, then the needle, armed with a ligature, is passed beneath it, and after its point has emerged towards the orifice of the wound, the ligature may be seized with the fingers or a pair of forceps and drawn out, leaving its centre under the artery. The ends of the thread are commonly tied with the sailor's knot, seen in Fig. 625.

The surgeon's knot, shown in Fig. 42, is liable to slip, and should not be used in the ligation of arteries. The vessel must not be stretched, or drawn from its bed in tying the knot; this may be avoided by holding the ends of the ligature between the thumb and last three fingers of each hand, while the index fingers are thrust to the bottom of the wound, and placed upon each side of the knot to support it during the time the ligature is being drawn tight (Fig. 624). Should the aneurism-needle not be at hand, the eyed probe bent at its extremity may be used instead, or even Belloc's sound, which is usually found in most all pocket-cases.

Fig. 625.

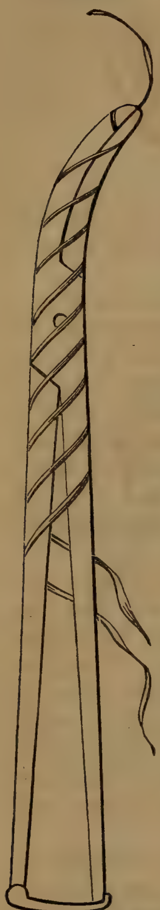


The sailor's knot.

Where the blood comes from an artery in such a position that it cannot be isolated, the ligature may be made to include the vessel and some of the adjacent tissues; the best instruments for this purpose are

the tenaculum-needle, seen in Fig. 626, and the forceps of Dr. Physick, shown in Fig. 627.

Fig. 627.



Physick's artery forceps.

Fig. 626.

Tenaculum-needle armed with a ligature.

When the ligature has been put on an artery, one of the threads should be cut close to the knot, and the other one brought out of the wound at its most depending point.

Wounded veins bleeding freely may also be ligated in the same manner as an artery; where a small orifice is simply made into their cavities it has been recommended to pinch up the margins of the wound, and tie them with a thread, thus avoiding the obliteration of the entire calibre of the vessel.

Two ligatures should always be put upon a bleeding artery if it is possible, one above the wound and the other below; or, if the vessel is cut through, one upon each of its extremities. In other cases, where it is impracticable to expose the point of injury, either through the original wound, or an incision made for the purpose, there is but one course left, to put the ligature upon the trunk of the artery above the wound.

Another plan of checking hemorrhage by pressure was practised by the ancient surgeons, and in later times was laid aside until revived by Prof. Simpson, of Edinburgh; we allude to *acupressure*. It is a valuable addition to the hemostatic means now in the hands of the surgeon, is susceptible of varied application, and in many cases possesses advantages over the ligature.

Prof. Pirrie, of Aberdeen, thus describes the principal methods of acupressure:—

"The *first method* consists in passing a needle through the flaps, or sides of the wound, so as to cross over and compress the mouth of the bleeding artery or its tube, just in the same way as in fastening a flower in the lapel of our coat, we cross over and compress the stalk of it with the pin which fixes it, and with this view push the pin twice through the lapel (Fig. 628). The only portion of the needle which is left exposed internally on the fresh surface of the wound is the middle portion of it, which bridges over and compresses the arterial tube at its bleeding mouth, or a line or two or more in the cardiac side of it. And if it were a matter of any moment, this part need not always be

left bare, for the needle could often be passed a few lines higher up, between the vessel and the cut surface, and, without emerging on that

Fig. 628.

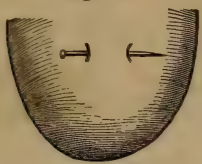


Fig. 629.

Mode of introducing the acupressure needle.

surface, more or less of both extremities of the needle, viz., its head and point, are exposed externally on the cutaneous surface of the side or flap of the wound.

"The *second method* consists in entering the needle on one side of the artery, pushing it behind, causing its point to emerge on the opposite side of the vessel, passing a loop of inelastic iron wire over its point, bringing the wire over the track of the artery and behind the stem of the eye end of the needle, drawing it sufficiently to close the vessel, and fixing it by a twist or half a twist around the needle. The wire with which the needle is threaded should be twisted, that it may be readily distinguished. By means of this twisted wire the needle can be pulled out, after which the loop of wire is liberated, and can be easily withdrawn.

"The *fourth method*, or *that by a long pin and a loop of passive iron wire*, is a modification of the third, and differs from it only in a long pin, with a glass head, for facilitating its insertion, being substituted for the common sewing needle threaded with iron wire. Perhaps of all methods the third and fourth are the most secure. The principle in each of these is the same; but Prof. Pirrie says he likes the modification of using long pins, when convenient, from the form of the wound, as they can be so quickly introduced, so readily withdrawn, and all wriggling and entanglement of different kinds of wire with each other avoided.

"The *fifth method*, or *that by the twist*, may be varied according to the extent of rotation of the needle, whether to a half or a quarter rotation. The operator has, on the cessation of bleeding, a reliable proof that a sufficient degree of rotation has been given to the needle. This method may be practised with a long pin or with a threaded sewing-needle, and with either it can be very quickly done; but of all methods of acupressure that by the twist with a long pin is the quickest. In acupressure by the twist to the extent of a half rotation of the needle, the first three movements given to the needle are precisely the same as in the third method above described, namely, it is entered on one side, pushed behind the artery, and its point is made to emerge on the opposite side. The needle is then twisted over the artery and fixed on the parts beyond. In this method the artery is, to a certain degree, both twisted and compressed. Prof. Pirrie says the first time he tried the method by the twist, a half rotation was given to the

needle: but so little pressure when direct is sufficient to arrest hemorrhage; in other cases a quarter rotation was only made by it.

"The *sixth method*, or that by *transfixion* and *twist*, as hitherto tried, in transfixing the tube of the artery, causing the point of the needle to emerge on the surface of the wound, giving a quarter rotation to the needle, and fixing its point in the tissues beyond the vessel.

"The *seventh method* consists in passing a long needle through the cutaneous surface, pretty deep into the soft parts, at some distance from the vessel to be acupressed, making it emerge near the vessel, bridging over and compressing the artery, and dipping the needle into the soft parts on the opposite side of the vessel and bringing out the point of the needle a second time through the common integument. In this method, the soft parts are twice transfixed, and the artery is compressed between the bone and the middle portion of the needle without the integument, between the first point of exit and the second point of entrance. Three portions of the needle are left without the integument, namely, its central portion and its extremities."

Prof. Pirrie says that "the first great point to be determined is, whether or not acupressure is a perfectly reliable method of checking surgical hemorrhage. That it is so, my belief is as strong as it could well be on any surgical point; and I have a decided impression that any surgeon who gives it a fair trial will assuredly arrive at the same conclusion.

"Besides being as reliable as any hemostatic yet employed, it appears to me to have the advantages of being the quickest, the easiest of application, and the safest means yet devised for arresting bleeding. That the vessels in a large amputation can be acupressed in a much shorter time than they can be ligatured I am perfectly satisfied; and in cases where every drop of blood is precious, it seems to me that to do all that can be done to preserve life, as far as saving of blood has influence, it is the duty of the surgeon in all suitable operations to give his patient the benefit of this new proceeding. But shortening the period occupied in arresting hemorrhage is not only important for diminishing one of the early dangers of an operation—namely, that from loss of blood—but also for lessening the risk of the more remote dangers of suppuration, and many distressing results of the higher grades of the inflammatory process in the stump. I have long thought we are too apt to forget that living tissues are resentful of even slight injuries, and that we are not sufficiently careful to use the sponge as seldom, and as gently as possible. Whatever shortens the period of hemorrhage must diminish the risk from frequent touching of the parts."

Tortion, once lauded as an efficient hemostatic means, is now abandoned except in its application to vessels of the smallest calibre. It consists in drawing out the mouth of the bleeding vessel with a pair of forceps about half an inch (Fig. 630); a second pair of forceps is now used to seize the artery at right angles to its axis and at its point of emergence from the surface, to hold it firmly while the vessel is being twisted upon itself by the first instrument made to revolve upon

Fig. 630.

Tortion of an artery.

its axis. In this manner, by seven or eight turns of the forceps, the middle and inner coats of the artery are ruptured and twisted in a knot which is to be returned into the wound.

CHAPTER XVI.

ON THE DRESSINGS OF WOUNDS.

THE dressings required by wounds will vary according to their nature, position, and complications; and it will, therefore, be convenient to consider them under the separate headings of *incised, punctured, lacerated, contused,* and *gunshot* wounds.

INCISED WOUNDS are solutions of continuity produced by sharp-edged instruments, such as a knife, hatchet, or sabre. They vary in length and depth from the smallest cuts with the edge of a penknife to those large incisions sometimes following blows with a sabre. These wounds may occupy any part of the body, and extend in any direction with its axis—transverse, longitudinal, or oblique. The local symptoms which characterize them are hemorrhage, pain, and separation of the lips of the wound.

The hemorrhage is always considerable when the incision is of any extent, or penetrates to some depth; the blood flowing immediately and freely from the orifices of the divided capillaries and arteries, which, if they are few and of the smallest size, soon contract upon the application of cold or astringent substances and cease to bleed; while, on the other hand, the blood will gush out in a copious stream if the large arteries are involved until the patient faints; and the hemorrhage will always prove fatal unless arrested by appropriate hemostatic measures.

The pain of incised wounds results from the division of the nervous filaments distributed to the part, and will vary in intensity according to the position of the wound, and the number of nerve filaments divided. In general, those seated upon the anterior plane of the body are more painful than those upon its posterior plane; and from the large supply of nerves to the face and palms of the hands, wounds of

these regions will also be very painful. The condition of the patient's mind at the time of the injury will have an important influence upon the degree of pain felt. When a person, for instance, is sharply engaged in a contest, with all his energies bent to the task of vanquishing his enemy, he may have a wound inflicted upon him and not feel it, or even know that the accident has occurred until he sees the blood flow.

The separation of the lips of the wound is a striking feature of this sort of injury, and it will take place in various degrees, depending on the shape of the instrument that inflicts the wound, the tension of the part at the time that it is inflicted, the elasticity of the tissues, and the amount of musclar contraction. The first circumstance—the shape of the instrument inflicting the injury—will influence the width of the gap by simply acting mechanically, the weapon serving as a wedge to force open the incision. The amount of separation caused in this way is always small, and in most cases is inappreciable; so also is that resulting from the tension of the part at the time the injury is received; for the moment the tension is removed, the edges of the wound approximate as far as the elasticity of the tissue and the muscular contraction will permit them.

The purely physical property of elasticity possessed by the textures plays a much more important part in causing wounds to gap than those hitherto mentioned. Its influence is well seen in incised wounds of the skin, which is the most elastic portion of the body; the margins of the incision open widely, displaying the structures beneath, which, though influenced to a certain extent by their elasticity, are much less so than the skin, and their borders do not, therefore, separate to an equal degree; the wound will in consequence possess a conical shape with its base at the surface. Muscular contraction excited by the wound, also, has an important agency in drawing its lips asunder, and its influence is most marked immediately after the infliction of the injury.

In the treatment of incised wounds, the indications are to remove all foreign matters that may have gained admission into them; to arrest hemorrhage, and to bring their edges into accurate contact.

The removal of foreign bodies may be accomplished by causing a stream of water to run over the wound; any particles that are visible may be seized and withdrawn with the forceps. Clots of blood are also equally inimical to union by first intention, and should be carefully cleared away from the wounded surfaces.

Hemorrhage is to be controlled by the means we have already pointed out in the previous chapter.

The third indication, that of bringing the wounded surfaces together and keeping them in accurate contact until they may have united, is effected in several ways, which require special description.

1. *Position.*—Position exercises an important influence in maintaining the edges of a wound approximated. In all cases, before recourse is had to other measures, the wounded part should be put in that position which permits the easiest approach of its margins, and this, of course, will vary with the situation and direction of the wound. If

the incision is transverse to the extensor muscles of the extremities, the position of extension is required; while in a similar injury of the flexors perfect relaxation is only to be attained by flexing the limb. In longitudinal wounds of the extensors, Boyer advised the limb to be flexed, and the reverse in similar wounds of the flexor muscles; but in this case, as the sides of the wound might be painfully drawn upon, it would be better to keep the limb straight, and the muscles in a state of equilibrium, depending rather upon adhesive strips and sutures to sustain the margins of the wound together.

2. *Agglutinatives.*—We have already considered, in Part I., the various kinds of agglutinatives—adhesive plaster, collodion, water-glass—and the mode of their application.

When using adhesive strips in the approximation of the borders of wounds, the parts should be shaved and cleansed before the application of the plaster; the strips are then laid over the wound after it has been drawn together, about a quarter of an inch apart, so that the blood or secretions may have ready egress. The strips need not be changed, as long as they serve their purpose, until cicatrization takes place; though usually at the end of three or four days, from the quantity of the discharge from the wound, from the plaster loosening, or from other causes, their removal becomes necessary. This must be accomplished with care, that the wound be not disturbed. The best plan is to seize one of the extremities of the strip in the fingers, and detach it as far as the wound; then in like manner treat the other extremity, so that the body of the strip shall be the last part removed. But one strip should be taken off at a time, and a new one immediately substituted for it, until the dressing is completed. If, upon examination, the strips are found not to require changing, the wound may be simply cleansed by allowing warm water to flow over it from a sponge held just above, which, combined with gentle pressure, will suffice to remove all the secretions in and about it.

M. Chassaignac has derived great benefit from his mode of dressing all descriptions of wounds by the *prolonged application of strips of adhesive plaster*. "This plan had been put into successful operation in respect to wounds accompanying comminutive fractures, large ones accompanied with laceration of tendons and aponeuroses, and wounds resulting from burns, bites of animals, amputations, and resection, &c. Since that period the same practice has been followed by him, and with the following results. 1. The immediate diminution of the traumatic pain in almost all cases. 2. The absence of traumatic fever in the majority. 3. Diminution in the amount of suppuration—an important point in the case of large burns and extensive wounds. 4. Prevention of the irritation, and numerous other inconveniences attendant upon the daily exposure of the wound for the purpose of renewing the dressing. 5. The much greater rapidity of the cicatrization, due to the amelioration in the character of the suppuration, the diminution of the inflammation, and especially the keeping the edges of the wound upon a level with its surface.

"This mode of dressing, as applied by M. Chassaignac, consists in the formation of a kind of cuirass over the wounded part, by means of

strips of adhesive plaster overlapping each other, and generally disposed in the form of an X. This artificial integument is covered with a piece of rag, perforated with holes, thickly spread with cerate, and everywhere extending beyond the plasters. This rag, covered with charpie, is kept *in situ* by compresses and bandages. This dressing remains on for eight or ten days. If there is too abundant a suppuration, the whole of the apparatus is renewed, with the exception of the plasters, which are not to be removed. During these eight or ten days the condition of the wound thus concealed is explored by means of gentle pressure made over the wound through the cuirass, or along the course of the lymphatics, the bloodvessels, the tendinous sheaths, and the principal nerves. If inflammatory action is present, a free application of leeches, made either in the vicinity or at a distance from the wound, suffices to disperse it.

"The two objects to be kept in view during the treatment by occlusion are, the keeping the surface of the wound itself constantly covered, and the disposition of the strapping so as to allow the discharge a free escape. But the surgeon must not imagine that when he has once applied the strapping, especially in the case of considerable lesions, as in compound fractures, the wounds from operations, crushing of the fingers, &c., he is dispensed from bestowing the greatest attention upon the progress of the case. Thus, if he does not daily expose the plaster to view, carefully examine by gentle pressure the condition of the subjacent parts, expel, by pressing towards the most depending parts, all accumulations of pus, carefully cleanse all parts of the cuirass contaminated by the pus, support by new strips any enfeebled part, and divide any of those which seem to be making injurious pressure, he will only spoil a good measure by his faulty application of it." (*Medico-Chirurgical Review*, Jan. 1860.)

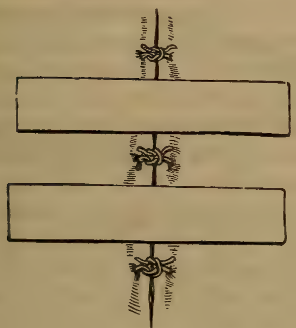
3. Position, aided by the agglutinatives, will in many cases secure the retention of divided surfaces in contact most perfectly; where the wounds are deeper, in addition to these, compression with suitable bandages will be required. We have already described the uniting bandages for transverse and longitudinal wounds at page 212, which, at the same time that they draw together their edges, make more or less compression. In some cases the object may be accomplished better by placing two compresses along either side of the incision, and securing them by a roller bandage extending from the toes or fingers to the root of the limb; in other instances, immovability and compression of the part may be secured most elegantly and efficiently by the starched bandage, taking care that no constriction ensues from inflammatory swelling.

Sutures are more often employed to bring the margins of wounds in contact, when they are of greater extent, and require, besides this approximation of their edges, that the parts beneath be supported. The principal sorts of suture used by the surgeon are the interrupted, continued, twisted, and quilled.

The *interrupted suture* is made with a curved or straight needle, armed with a metallic or a well-waxed silken or hempen thread, of a thickness proportioned to the size of the wound. One of the margins

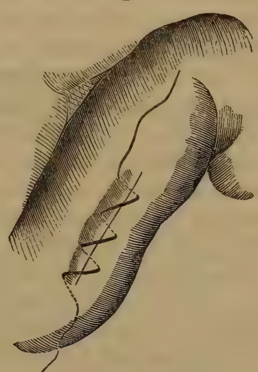
of the incision is steadied with the thumb and index finger of the left hand, while, with the right, the needle is caused to perforate it from *without inwards*. The point of the needle is again entered upon the inner face of the opposite margin, and carried from *within outwards* to pierce the skin at a distance from the wound equal to that of its point of entrance. In this manner the required number of sutures are introduced from a half to three-quarters of an inch apart, and their ends are then tied with the reef-knot, as seen in Fig. 631, without, however, constricting the tissue inclosed in the loop; the knots should be upon the side of the incision, and not over it, as shown in the figure. In superficial wounds, the threads should not pass through the fibrous or muscular tissues; while, in other cases, their depth must be such as to secure the closest approximation of the wound. The distance at

Fig. 631.



The interrupted suture.

Fig. 632.



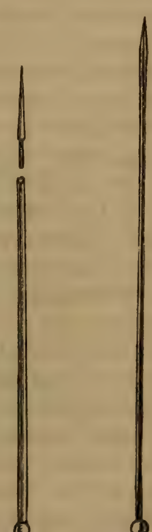
The continuous, or Glover's suture.

which the needle is entered from the incision will also vary with its extent, from two or three lines to a quarter of an inch.

The *continuous suture* is executed, as in the previous instance, with a needle and thread. The needle is pressed obliquely through both margins of the wound, its point entering upon the same side at every stitch, so that the thread describes a spiral between the extremities of the incision. This suture is principally employed in wounds of the intestines and abdomen (Fig. 632).

The *twisted suture* requires pins or straight needles, with spear points, such as are seen in Figs. 633 and 634; the former being the old form of needle used in hare-lip, and the latter the new and improved one. The best material of which to prepare these needles is gold, as it does not become oxidized and irritate the parts, or adhere to them when incrusted with dried blood or pus. The needles most commonly em-

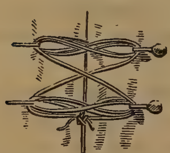
Fig. 633. Fig. 634.



Needles for twisted sutures.

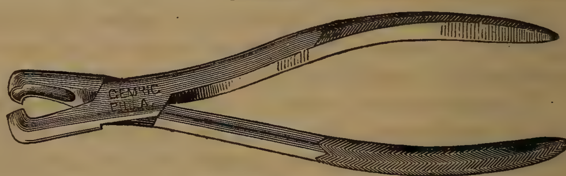
ployed, however, are those made of steel, of the shape seen in Fig. 634. The suture is made in this manner: The lips of the wound are held in accurate contact, and then the needle or pin held in the fingers or forceps is passed through them both, at that point first where it is most important to obtain union; then, in succession, other needles are introduced in like manner at convenient distances until a sufficient number has been used. The surgeon now takes a piece of thread in both hands and entwines its loop around the first pin in the form of an ellipse, or, what is more common, in the form of a figure of 8 (Fig. 635). The threads are then crossed over the intervening space, and a figure of 8 made upon the second pin, and so on until they are all encircled with the threads. The points of the pins must then be cut off with the pliers (Fig. 636), that they may not wound the patient, or catch in the clothes.

Fig. 635.



Twisted or hare-lip suture.

Fig. 636.



Pin-pliers.

At the end of three or four days, or earlier, according to the circumstances of the case, when the suture is to be removed, the pins are to be seized by their heads with a pair of forceps and drawn out, while the thread is supported by the point of the left index finger. The thread either falls at the same time, or, what is more common, remains sticking to the skin two or three days longer.

A very elegant modification of the twisted suture has been recently

Fig. 637.

India-rubber suture.

Fig. 638.

Quilled suture.

introduced into practice by M. Gariel, consisting in the substitution of little India-rubber rings for the threads, and applied as seen in Fig. 637. The rings are obtained from sections of India-rubber tubes of any desired size.

The *quilled suture* (Fig. 638) is made by passing through the edges of the wound a number of double threads at intervals of about an inch, with a curved needle—or, better, with the tenaculum-needle. A quill, piece of bougie, or a slender stem of wood is put under the loops formed by the threads upon one side of the wound; the extremities of the threads are then separated, and a piece of bougie placed between them, over which they are to be tied sufficiently firm to hold the margins of the wound in contact.

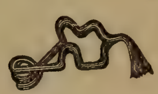
In removing this suture, which is principally used in rupture of the perineum, it suffices to cut the loops, when the threads may be readily withdrawn.

What is called the *dry suture*, consists in fastening along the margins of a wound two narrow strips of adhesive plaster, and then sewing their contiguous margins together.

There are other forms of suture used in special cases—such as the *tongue and groove suture* of Prof. Pancoast; the *button suture* of Dr. Bozeman, and the clamp suture of Dr. Sims, a description of which does not fall within our limits.

M. Vidal has invented an ingenious little instrument for maintaining the edges of a wound together, and for which he was awarded a prize by the Institute of France. It is made of fine silver wire, bent in the form seen in Fig. 639. The points are toothed so that they will take firm hold upon the margins of the incision, and sustain them in contact by the spring of the wire. The instrument acts very superficially, and cannot be used in wounds of any depth.

Fig. 639.



The serrefine.

Under the most favorable circumstances, when the edges of incised wounds have been brought into exact apposition, their union may take place by *immediate adhesion*, that is, no inflammation will be developed, or effusion of plastic matter occur; but the continuity of the fibres, bloodvessels, and nerves will be *immediately* re-established, and no cicatrix will remain.

Another mode of healing, sometimes observed, is that called by McCartney the "modelling process;" it consists in the breach in the tissues being repaired, without inflammation, under a covering or scab formed by the concretion of blood or the secretions of the part; or, an artificial crust may be formed with gum Arabic or any other bland absorbent powder.

Union may be effected in a third mode, or by *adhesive* inflammation; the margins of the wound become moderately inflamed and swell a few hours after the injury, and a reddish plastic fluid is effused between them, which is promptly organized into a bond of union.

Should the degree of inflammation surpass that required for the formation and organization of the effused plasma, the surfaces of the wound become covered with a yellowish-white vascular membrane

studded with small projecting points called granulations, which are enveloped with pus.

If now these granulations are kept in accurate apposition, they may unite, constituting what is called union by *second intention.* When the granulating surfaces are not brought together, but left exposed to the air, the membrane covering them acquires increased thickness, and contracts, drawing their margins towards the centre of the wound, while the granulations now level with the surface become smaller, and those at the circumference of the wound covered with a thin bluish pellicle which gradually extends towards the centre until the whole surface is covered with a cellulo-fibrous membrane called a *cicatrix.*

B. Contused Wounds are produced by blunt weapons, such as a club, by the passage of a wheel over the body, or by gunshot; the parts are torn or bruised in various degrees from the mere laceration of the skin and a few small bloodvessels to the complete disorganization of muscles, bloodvessels, and bones. In the latter case, there is always great shock inflicted upon the system; the patient is prostrated with a feeble pulse, bleached skin, and cold extremities, and when reaction set in, will frequently vomit.

From the damage done to the nerves there will generally be considerable pain felt unless the parts are disorganized, when it may not be present at all; the bloodvessels being bruised, the blood will speedily coagulate in them and prevent hemorrhage.

The margins of the wound are generally irregular, torn, and infiltrated with blood.

When the injury is inflicted without breaking the skin, it is called a *contusion,* in which the smaller vessels only may be torn, giving rise to an infiltration of blood beneath the skin, or ecchymosis; or larger arteries will sometimes be involved and the blood escape in greater or less quantity so as to form collections of different magnitudes, from the size of a small nut to that of an infant's head, or even larger.

In the treatment of contusions the object will be to check inflammation, and subsequently to promote the absorption of the effused blood. The first indication is fulfilled by the application of leeches, cold water-dressings, solutions of the acetate of lead and opium, or a mixture of alcohol and water; and the second by stimulating infrictions of camphorated alcohol, tincture of arnica, or such like substances. Under this treatment the ecchymosis will usually disappear in a few days; large collections of blood may be removed by a small incision through the skin. In contused wounds, such of the lacerated parts as possess vitality should be thoroughly cleansed and brought together by suture and adhesive strips. If there is any hemorrhage, it must be suppressed by the means we have already pointed out. Inflammation must be kept down by the use of cold applications; or, when pretty active, leeches may be had recourse to. During the time that the sloughs are separating, secondary hemorrhage may occur, and should be met by appropriate measures.

C. Punctured Wounds.—These wounds are inflicted by such in-

struments as the sword, bayonet, lance, knife, nails, splinters of wood, or any other sharp-pointed and hard body. If these instruments are slender, well polished, and sharp, they penetrate the body by separating the fibres of the tissues, and there will be little or no laceration; while other objects that are rough, thick, or blunt, will produce more or less contusion in tearing their course through the soft parts.

Punctured wounds will vary much in character, according to their position, extent, and the nature of the instrument with which they have been inflicted.

The pain which accompanies them is most generally very severe, especially when they are produced by some rough object, and occupy a position among the fasciæ, or parts abundantly supplied with nerves. There is rarely any amount of blood observed to flow from the puncture, and should a large artery be perforated, the hemorrhage will occur in the surrounding tissues, forming traumatic aneurism.

This variety of wound is the one most often followed by such complications as abscess, tetanus, erysipelas, &c.

The indications of treatment in punctured wounds are to remove all foreign bodies from them with the fingers or forceps, assisted, if necessary, by appropriate incisions; to check hemorrhage by the application of compressors, ligature, or other hemostatic means; and to control inflammatory action by the use of local antiphlogistics.

D. Gunshot Wounds.—Gunshot injuries are contused and lacerated wounds produced by the explosion of fire-arms, as pistols, rifles, cannon, &c. They are of different degrees of gravity, according to their extent, location, and the character of the projectile by which they have been occasioned. In most cases there will be more or less *shock* produced by the injury. The pain is not great as a general rule: and I have seen a number of instances in which the limb was perforated by a Minie ball and the bone shattered, yet there was no pain: the patient complained only of a feeling of weight in the part as long as it remained quiet. Lulled into a sense of false security by this absence of pain, patients have often become the victims of their own imprudence, in their great anxiety to save their limbs, by declining surgical interference at the opportune moment; and not until the lapse of three or four days, when inflammatory action has set in and the limb becomes swollen and painful, do they feel the futility of their hopes and the rashness of their conduct.

The hemorrhage from gunshot wounds is usually small; sometimes, however, a large artery may be divided by a ball moving with great velocity, and copious bleeding follow. What the surgeon has most to fear in this respect is secondary hemorrhage, which generally takes place between the fifth and twenty-fifth days. In either case the imperative rule is to ligate both extremities of the artery, should it be possible; if not, put the ligature upon the trunk above the wound.

The injury should be examined as soon as practicable after its infliction, and all foreign bodies removed from it, such as bullets, pieces of clothing, fragments of shell, &c. The best probe, if it can be used, is the finger, which should be gently introduced, and all parts of the wound fully explored with it; in other cases a stout probe (Fig. 27,

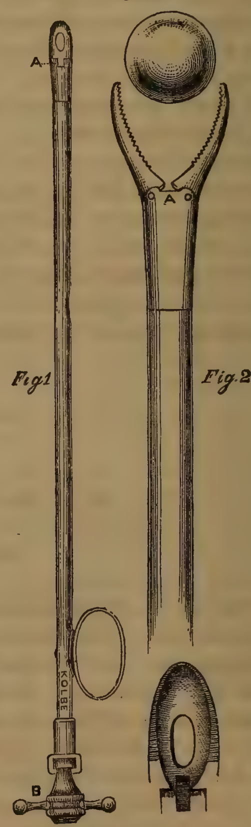
p. 41), eight or ten inches long, may be employed to penetrate to greater depths than can be reached with the finger; a straight silver catheter may be used for the same purpose. If a leaden object is present, a very ingenious method of detecting it is with Nélaton's probe, which is simply a long metallic stem tipped with a little ball of unglazed porcelain; the slightest contact of the ball with the metal will produce a black stain. MM. Fontan and Favre recommended for the detection of metallic objects an explorer composed of two insulated wires connected with a single cup of Smee's battery; the explorer coming in contact with the metal, establishes a galvanic current, which is indicated by the deflexion of a galvanometer attached to the apparatus. The plan is ingenious, but entirely destitute of practical utility.

For withdrawing bullets and other objects, the most useful instrument will be a pair of long, slender-bladed forceps, such as are seen in Fig. 640. Should the body be felt beneath the skin, an incision

Fig. 640.

Bullet-forceps.

Fig. 641.

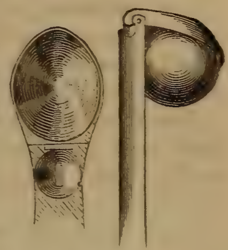


Kolbé's bullet-forceps.

must be made upon it, and the body turned out of its bed with the finger or forceps; the rule to follow, in such cases, being to remove

all foreign matter from that point of the surface to which they are nearest. The bullet-forceps of Mr. Kolbé, a skilful instrument-maker of Philadelphia, may also be employed to remove bullets. It consists, as shown in Fig. 641, of a metallic tube with two short serrated jaws articulated with one of its extremities, and capable of being expanded or closed by turning a screw placed at the other. The instrument is introduced closed, and may be used as a probe; when the bullet is felt, it is at once grasped by opening the jaws of the forceps.

Fig. 642.



Bullet-extractor.

The instrument sketched in Fig. 642 has a movable point, which may be bent by the stem running through the tube, at a right angle with the latter. The extractor is introduced into the wound beyond the object, when its point is thrown down, as seen in the figure. The inner surface of the point is concave, to embrace the ball.

When the missile is buried in the bone, it may require the use of the trephine or gouge to remove a sufficiency of it adjoining the ball to allow the forceps to get a good hold upon the latter. The sharp-pointed screw, so much employed in former times for extracting balls, is now justly abandoned.

After the foreign bodies have been removed and the wound thoroughly cleansed, its sides must be supported with adhesive plaster, or compresses and a roller bandage. To control subsequent inflammatory action, cold water-dressings will generally be found most agreeable; and should sloughing impend, they must at once be abandoned for warm applications. When there is any burrowing of pus, free incisions should be made to evacuate it.

CHAPTER XVII.

ANÆSTHESIA.

The minds of surgeons had been from a remote period engaged in fruitless efforts to discover some means of preventing pain during surgical operation; but it was not until the year 1847 that success crowned their exertions. This desideratum must have been felt by the older surgeons, previous to the revival of the ligature as a hemostatic agent by Ambrose Paré, much more severely than since that period; for to check a hemorrhage, now controlled by a single thread, the only means in their possession were the red-hot knife, or the searing cautery; and sometimes bleeding stumps were thrust into pots of boiling pitch. Such means might well cause the most resolute and enduring to recoil from the severities of a surgical procedure, especially when nothing beyond the temporary numbing of the sensibilities by opium or other narcotic could be obtained.

Local Anæsthesia.—The methods that have been employed to produce local anæsthesia at different periods may be considered under three heads: Compression, local narcotization, and refrigeration.

Compression has been made in two ways, either directly upon the part to be incised, or upon the trunk of the nerve leading from the limb. In the first instance we see an illustration of the numbing influence of pressure in the anæsthetic effect of pinching the edges of a wound between the fingers before passing the needle through them in making a suture. Compression upon the trunk of the nerve was particularly brought forward by Mr. John Moore, of London, who invented an instrument for the purpose analogous to the compressor of Dupuytren already described; one of the pads of the instrument was placed over the sciatic, and the other over the crural nerve: several operations were performed upon the lower extremity, while the apparatus was applied, but anæsthesia was so imperfectly attained that that plan was soon abandoned.

Local narcotization was long ago practised for the object of annihilating pain during operations. M. Bouisson states that he applied a plaster of opium to the toe of a patient for some time, and afterwards succeeded in partially tearing away the nail without causing pain; he was also in the habit of using belladonna ointment to relieve the pain of the operation for fissured anus. A plan was pursued some years ago of smearing bougies, catheters, etc. with narcotic ointments, while dilating, cauterizing, or incising stricture of the urethra.

Refrigeration may be produced in several ways. The old plan was to apply to the parts demanding surgical interference, various frigorific mixtures, usually ice and one of the salts of sodium or potassium; equal parts of pounded ice and common salt is as good a mixture as any other for this purpose. Its anæsthetic effects are restricted to the skin and cellular tissue, and will not, therefore, be available in operations requiring the incision to go deeper than those structures. I have used it in opening buboes, abscesses, and in superficial incisions with success.

A simple apparatus is required in applying the ice mixture; a pig's bladder, or a piece of oiled silk; the temperature must be brought below 32° Fahr., perhaps between 15° and 25° will be as safe, which will produce the requisite degree of anæsthesia in from fifteen to twenty minutes.

This method may be employed where the apparatus of Mr. B. W. Richardson is not at hand, and it will answer very well in the class of cases above mentioned.

The ingenious contrivance of this gentleman leaves little to be desired for the convenient and efficient application of cold in the production of local anæsthesia. The apparatus which he originally devised consisted "simply of a graduated bottle for holding ether; through a perforated cork a double tube is inserted, one extremity of the inner part of which goes to the bottom of the bottle. Above the cork a little tube connected with a hand bellows pierces the outer part of the double tube, and communicates by means of the outer part by a small aperture with the interior of the bottle. The inner tube for

delivering the ether runs upwards nearly to the extremity of the outer tube. Now, when the bellows are worked, a double current of air is produced, one current descending and pressing upon the ether, forcing it along the inner tube, and the other ascending through the outer tube, and playing upon the column of ether as it escapes through the fine jet."

This instrument has been further improved by substituting for the bellows two India-rubber balls, which render it more convenient and portable, without destroying the efficiency of its action.

"By this simple apparatus, at any temperature of the day, and at any season, the surgeon has thus in his hands a means for producing cold even 6° below zero; and by directing the spray upon a half-inch test-tube containing water he can produce a column of ice in two minutes at most. Further, by this modification of Siegle's apparatus he can distribute fluids in the form of spray into any of the cavities of the body—into the bladder, for instance, by means of a spray-catheter, or into the uterus by a uterine spray-catheter."

"When the ether spray thus produced is directed upon the outer skin, the skin is rendered insensible within a minute; but the effects do not end here. So soon as the skin is divided, the ether begins to exert on the nervous filaments the double action of cold and of etherization; so that the narcotism can be extended deeply to any desired extent. Pure rectified ether used in this manner is entirely negative; it causes no irritation, and may be applied to a deep wound, without any danger. I have applied it direct to the mucous membrane of my own eye, after first chilling the ball with the lid closed."

Reaction from the anæsthesia is in no degree painful, and hemorrhage is almost entirely controlled during the anæsthesia.

One or two precautions are necessary. It is essential, in the first place, to use pure rectified ether; methylated ether causes irritation, and chloroform, unless largely diluted with ether—say, one part in eight—does the same.

General Anæsthesia.—Various plans have been suggested and tried from an early period in the history of surgery, to render patients insensible during the performance of surgical operations. The ancients used the root of the mandrake steeped in wine; Theodoric, in the thirteenth century, recommended the inhalation of opium, and in 1538 we find Canappe imitating Theodoric in using narcotics by inhalation for the same purpose.

Sir Humphry Davy, in 1799, remarked that "as nitrous oxide, in its extensive operation, appears capable of destroying physical pain, it may probably be used with advantage in surgical operations."

In 1844, Dr. Horace Wells employed the nitrous oxide in his own case, having a tooth extracted painlessly; he afterwards gave it to several patients upon whom a similar operation was performed, with the most gratifying success.

Mesmerism was practised by Dr. Esdaile, a surgeon in India, and he states that he had submitted patients under its influence to the larger operations without causing them the slightest pain.

Hypnotism, a name given by Mr. Braid to a sort of somnambulic

sleep produced by intently gazing at a bright object, has also been had recourse to for the purpose of producing anæsthesia.

Both of these processes are uncertain in their operation and of little or no practical use to the surgeon.

Ether was first used as an anæsthetic by Dr. Morton, a dentist of Boston, in 1834, for the purpose of preventing pain during the extraction of teeth.

He afterwards etherized two patients undergoing surgical operations, one for Dr. J. C. Warren and the other for Dr. Haywood.

Since that time it has been employed in every portion of the civilized world, and, mixed with chloroform—usually three parts of the former to one of the latter—is generally preferred for anæsthetic purposes by American surgeons. Some, however, still give the preference to chloroform, and during the late war it was more commonly used than ether by the military surgeons, and given in thousands of cases with the most gratifying results.

I have used it in many cases, and never saw any bad effects follow. In those patients, even, who had suffered severe shock chloroform was often employed as a stimulant along with brandy, and where immediate operations were required no unnecessary time was lost from any fear that its administration would add to the depression already present from the injury.

Up to the present time there have been but few instances of death following the use of ether, while chloroform reckons among its victims some hundred or more. Various reasons have been assigned for this difference. The fact that chloroform is more energetic than ether is undoubted, and that it requires greater care in its administration to insure security from accident is also certain; and, lastly, it has been observed that it may undergo changes by exposure to light and heat, so that poisonous compounds are developed by the chemical reactions following.

To a want of proper attention to the first point mentioned, at the introduction of chloroform into surgical practice, may be attributed some of the fatal cases. Too large a quantity of the agent being used without due regard being paid to the admission of air. Other cases resulted from syncope, by giving the chloroform while the patient was in an erect posture, thus opposing to the action of an already enfeebled heart, the retarding influence of gravity. Under this head, perhaps, fall the unfortunate cases (which are by no means an inconsiderable portion of the whole number) of the dentists.

As to the third point—chemical changes in the chloroform producing poisonous compounds—it is recorded that this anæsthetic was given during the Crimean War in 12,000 cases, with but one death resulting from the agent, and in this instance the chloroform used was in a forward state of decomposition; from the want of any other evidence of the cause of the fatal termination, death was attributed to the poisonous compounds developed by these chemical changes.

Latterly we hear unfrequently of fatal cases from the use of chloroform, and this infrequency will amount to total immunity when the importance of the three foregoing facts is fully recognized and

properly attended to. In other words, chloroform in proper quantity, of good quality, and carefully administered, may be as safely used in operative surgery as ether.

That chloroform will ever be supplanted by any anæsthetic yet discovered is quite improbable; and the success which has attended its employment in thousands of cases of surgical operations, during the war of the rebellion, has given the uprising generation of surgeons a confidence in the value of this agent that must remain unshaken.

Mr. Arnott, of London, the champion of local anæsthesia, has endeavored to prove, by statistics, that since the introduction of the anæsthetics the mortality after surgical operations has been materially increased. But all statistics drawn from a comparison of total operations of all classes before and after the employment of these agents will not fairly settle the question of the relative mortality, inasmuch as with the anæsthetics, surgeons have been enabled to bring within the limits of application of the knife a large number of operations that had hitherto been rarely, or not at all, attempted, and among which there was necessarily a large number of fatal cases.

The only proper method would be to compare the same classes of operations with each other performed before and since the discovery and use of the anæsthetics; that is, amputations with amputations, lithotomy with lithotomy, &c.

It is my opinion, based upon the observations of numerous cases during the war, that the use of chloroform improved the chances of recovery by diminishing the shock of the operation and giving the surgeon another advantage of no mean value, namely, complete control over the patient so that he may proceed with his incisions with accuracy, certainty, and a reasonable amount of leisure.

It has been stated that chloroform changes the character of the blood and diminishes the tone of the capillaries, thereby giving rise to a greater frequency of secondary hemorrhage after operations. This result did not occur as far as I was enabled to judge in any of the cases that came under my observation, although chloroform was invariably employed when operative interference was required, and particular attention was paid to this point with a view of ascertaining the actual influence exercised by the agent in this respect.

The inhalation of chloroform should be avoided in operations about the jaws and fauces where it may happen that in consequence of the insensibility of the patient the blood will flow into the glottis and produce suffocation. Ether, producing a much less sedative effect upon the heart's action, will be preferable in those cases in which operations are to be performed upon patients in a sitting posture, or where it is desirable to induce only a partial anæsthesia, that the patient may coöperate with the surgeon during the performance of operations about the throat.

When chloroform is being employed the patient should always be placed in a recumbent position. About a drachm of the agent is poured upon a towel folded in the shape of a cone and held over his nose and mouth, some little distance from the face, that the air may be freely mixed with the vapor as it passes into the respiratory passages.

I often administered it by directing a small piece of cotton cloth to be laid over the patient's nose and mouth, and the chloroform dropped upon this in small quantities at a time, until the desired effect was produced; the cloth being thin, permits the air to reach the lungs through its meshes in due quantity. In order to prevent the loss of the chloroform by evaporation, in adopting this plan, I usually cover the cloth with a piece of oiled silk of corresponding size; the lower margins of the two pieces must be raised a little, so that the air may gain ready access with the chloroform during the inhalation. Rapid anæsthesia, economy of the chloroform, and an abundant supply of air are the advantages of the plan; it may also be mentioned that the eyes and face are freed from the contact of the liquid.

When the patient has been fully chloroformized, the inhalation should be momentarily suspended, and afterwards resumed at the moment the patient shows signs of returning consciousness, which will be evinced by some muscular effort. The quantity of chloroform poured upon the towel needs to be diminished at every dose. In this manner anæsthesia may be safely maintained for several hours together; during this time the patient should be narrowly watched, an assistant being detailed to note the pulse and at the same time attend the appearance of the countenance and the condition of the respiration. The moment the pulse becomes weak, the face pale, and the respiration embarrassed or stertorous, danger is imminent, and the anæsthetic must be discontinued.

Sometimes unpleasant results follow want of attention to a certain preliminary preparation, which is of the first importance both as regards the safety of the patient and the result of operations. First, before the anæsthetic is administered the stomach should be empty, otherwise vomiting will almost surely follow the inhalation, which, in operations upon the eye, may cause the loss of that organ; besides, the act of emesis being attended with more or less depression, may contribute measurably to the suspension of the heart's action, already enfeebled by the influence of the chloroform. Another advantage derived from attending to this point is that the diaphragm will have freer play in sustaining the respiration when not obstructed by a distended stomach.

Secondly, all articles of clothing about the patient's person should be loosened, so that the walls of the thorax and abdomen be not compressed, to the detriment of a vigorous respiration.

Thirdly, the inhalation should be gradual, so that the system may have time to accommodate itself to the altered conditions of functional activity; the rapid administration of chloroform will produce a sort of shock, that may be fatal.

Fourthly, the surgeon should assure himself that the chloroform is pure.

The article obtained from methylated spirit is the best, but the ordinary article can generally be depended upon. The usual impurities are alcohol, the pyrogenous oils, and ether. If we place in a test-tube a little distilled water, and pour into it, *guttatim*, chloroform, if there is any alcohol present the mixture will become somewhat milky, but if that fluid is absent, the chloroform will fall to the bottom unchanged;

a little of the albuminous fluid of an egg added to chloroform containing alcohol will be promptly coagulated. When poured upon the hand, any pyrogenous oil will leave upon it a greasy feel when the chloroform has evaporated. The addition of sulphuric acid will change the color of the oil to yellow or brown. If the suspected fluid be poured upon a sheet of white letter-paper, it leaves a greasy spot, produced by the absorption of the oil. Adulteration with ether is easily recognized by applying a flame to the mixture, which immediately inflames; pure chloroform is combustible, but not inflammable.

The quantity of chloroform required in each case will vary with the age, sex, and susceptibility of the patient, and the duration of the operation; generally between half an ounce and an ounce will do, but in prolonged operations ten to sixteen ounces may be required. Young children require very little, and, as a general rule, females are more susceptible to its influence than males. Age is no bar to the administration of chloroform.

If the agent has produced poisonous effects indicated by the changes in the countenance, breathing, and pulse mentioned above, the inhalation must be instantly suspended, and recourse had to the following means of resuscitation:—

1. Secure the largest possible supply of fresh air by throwing open the windows and doors.
2. Dash cold water upon the face and chest of the patient.
3. Establish artificial respiration by Marshall Hall's plan for inflating the lungs, or, what I think better, that known under the name of Dr. Sylvester's method, which consists in raising the arm above and parallel with the head at regular intervals, so that the ribs may be alternately elevated and depressed fifteen or twenty times per minute. A third plan is also recommended by some—inflating the lungs by blowing into the patient's mouth; as this introduces more or less carbonic acid gas, it has been suggested to substitute for the mouth a pair of bellows.
4. Run the point of the index finger over the tongue to its base, which may then be pressed forward, and the superior opening of the larynx gently touched so as to excite reflex action.
5. Prof. Nélaton says that a plan which has always succeeded with him, and never to be neglected in these cases, consists in suspending the patient by the heels.
6. Counter-irritation of the skin by percussing it with the hands, the application of mustard plasters, mustard baths, &c.

Stimulating vapors, such as that of liquor ammoniæ, may be held beneath the nose; enemas of oil of turpentine will also be of service. As soon as the patient can swallow, brandy or other stimulant should be given.

It has been recommended to pass an electrical current along the spine.

The same amount of care is not required in administering ether as chloroform, as it does not act near so energetically as the latter.

The inhalation may be effected by pouring the ether into a coni-

cally-shaped sponge moistened with water and covered with oiled silk; a folded napkin or towel will also answer very well.

The first dose for an adult may be half an ounce; the first whiffs of the vapor generally produce a slight cough and acts of deglutition, which soon, however, subside and are followed by a condition of exhilaration, sometimes violent excitement; in a few seconds the patient becomes quiet, muscular relaxation and complete insensibility ensuing.

When the patient begins to recover from the anæsthesia, he generally evacuates the contents of the stomach, if it happens to contain anything. He feels confused, and there is some pain in the head, which last sometimes continues a day or two; the odor of the vapor also hangs to the patient's breath for two or three days.

The quantity of ether required in each case, under ordinary circumstances, will be from four to six fluidounces, but in prolonged operations as much as fifteen or twenty ounces may be demanded. To produce complete anæsthesia the vapor must be breathed at least ten or twelve minutes, and sometimes it takes twenty or thirty, according to the age and susceptibility of the patient.

The whole series of ethers possess properties analogous to those of sulphuric ether.

Other agents besides the ethers and chloroform have been used as anæsthetics, among which are chlorocarbon, chloride of olefiant gas, bromide of ethyl, amylene, and keroselene. Chlorocarbon, or the bichloride of carbon, is a transparent, colorless fluid, having an ethereal odor and sweetish taste, not unlike chloroform, to which it still further assimilates in its quality and effects, but is more dangerous than it, from the greater depressing influence exercised over the actions of the heart. The chlorocarbon has been used by inhalation, introduced into the stomach, and in the form of a vapor douche. In the latter mode particularly has it been found advantageous in hysteralgia, and painful affections of the rectum. Prof. Simpson employed a simple apparatus for the application of the douche, consisting of a common enema syringe with the nozzle introduced into the vagina, and the other extremity of the apparatus placed an inch or more down into the interior of a four ounce phial containing a small quantity, as an ounce or so, of the fluid whose vapor it is wished to inject through the syringe.

Chloride of olefiant gas and the bromide of ethyl have both been used by Mr. Nunnely, of Leeds, and he believes them to possess important advantages over chloroform. Patients can be put under their influence and kept insensible for any length of time, during the performance of the most painful operations; both these agents act speedily, pleasantly, and well.

Amylene was experimented with by MM. Caillot and Giraldès, and made the subject of a report to the Academy of Medicine by M. Robert. This agent is extremely fetid, produces the most violent symptoms in a few moments, while they as rapidly pass away. It has proved fatal in one case in the hands of Dr. Snow, of London, and, possessed of much safer and more convenient anæsthetics, the profession has very properly abandoned its use.

Keroselene, a liquid hydrocarbon with a tasteless and unirritating vapor, has been but lately brought forward, and requires further experiments to ascertain its value as an anæsthetic.

Several other agents possess anæsthetic properties in some degree, but they are of no practical value, inasmuch as the majority of them have not been tried upon the human subject. The reader is referred for further information as regards these agents to *The Transactions of the Provincial Med. and Surg. Association*, London, vol. xvi. p. 177.

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